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ABSTRACT

This five-unit volume is intended for use principally as a guide to the teaching of environmental education in upper secondary schools in Barbados. Topic areas of units include: (1) the environment and environmental conservation; (2) erosion/conservation and land use/misuse; (3) destruction/protection of wildlife and the importance, destruction, and conservation of vegetation; (4) water pollution/management, air pollution and preventative measures, and destruction and preservation of the marine ecosystem; and (5) natural disasters and their effects on the environment. Provided for each unit are an introduction (giving an overview of unit subject matter), a list of general objectives, a list of concepts (major generalizations or subject matter to be learned), a list of materials/equipment needed, a list of subject areas to which the unit may be correlated, and lesson plans. Lesson plans suggest ways in which various aspects of the unit may be taught. They are divided into the following areas: specific objectives, learning activities, assignments, and evaluation methods. Also provided is an appendix containing maps and other resource materials which teachers may find difficulty in obtaining. (JN)

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ENVIRONMENTAL EDUCATION MANUAL

Teacher's Guide to Environmental Education

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Caribbean Conservation Association

TITLE XII
U.S. AID

The Ohio State University

Prepared for the

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INTRODUCTION

Concern about environmental quality, economic development, related environmental impact and the quality of life led to an outpouring of concern that culminated in the 1972 United Nations Conference on the Human Environment (Stockholm, June, 1972). Recommendation 96 of the Stockholm Conference challenged various UN organizations, especially UNESCO, and governments of the world to take the steps necessary to establish an international program in environmental education. The environmental education program was to be interdisciplinary in emphasis and appropriate for in-school and out-of-school use, encompassing all levels of education and also directed toward the general public.

Environmental Education is concerned with an individual's understanding of himself, his fellow man, the environment, and the interrelationships within and among each of these constellations of concern. A major goal is to encourage the individual to develop the ability to make thoughtful decisions which will create an environment that allows him to live a quality life. Specifically, environmental education is concerned with developing a citizenry that is:

1. Knowledgeable about the biophysical and sociocultural environments of which man is a part;
2. Aware of environmental problems and management alternatives of use in solving those problems; and
3. Motivated to act responsibly in developing diverse environments that are optimum for living a Quality Life.[1]

Thus it can be seen that environmental education is concerned with knowledge of the universe, the biosphere, society, and the individual, in that is not only attempts to provide the individual with environmental

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1. Robert E. Roth, et al., Environmental Management Concepts--A List. Madison: University of Wisconsin, Center for Cognitive Learning, 1970.

understandings, but also views him as a potential creative being and encourages him to accept the responsibility of decision-making which is his by virtue of being human.

The Caribbean Conservation Association and the Division of Environmental education of The Ohio State University, with the support from the U.S. AID Title XII Strengthening Program, are pleased to provide this draft of a Teacher's Guide to Environmental Education for your use and comment. Through Environmental Education workshop participation by teachers and conducted in Barbados evaluative information concerning the accuracy useability of the Teacher's Guide will be obtained. A final draft will subsequently be prepared for distribution to teachers and other environmental educators in Barbados.

The Guide is to be used as an idea source and as a stimulus to encourage educators to develop appropriate environmental education activities, lessons and units that will help develop a new generation of environmentally literate and caring citizens.

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A NOTE TO THE TEACHER

This volume is intended for use principally as a guide to the teaching of Environmental Education in upper secondary schools in Barbados. The volume is not intended to be exhaustive as a whole or in parts. The teacher is, therefore, encouraged to create some completely new lessons as well as to supplement or modify various aspects of lessons to suit the needs of the particular group of students in the class.

A few comments on major categories within the volume may be helpful to those using it.

I. Units

The volume contains the following five units:

Unit I		The Environment and Environmental Conservation
Unit II	(a)	Erosion and Conservation
	(b)	Land - Use and Misuse
Unit III	(a)	Wildlife - Destruction and Protection
	(b)	Vegetation - Importance, Destruction and Conservation
Unit IV	(a)	Water - Pollution and Management
	(b)	Air - Pollution and Preventive Measures
	(c)	The Marine Ecosystem - Destruction and Preservation
Unit V	(a)	Natural Disasters and their Effects on the Environment
	(b)	Looking Ahead
Appendix		Reference Materials

2. Introduction

For each unit there is an introduction which gives an overview of the subject matter of the unit. This introductory statement provides useful background information for the teaching of the unit. Since the statement is not meant to be exhaustive, it is expected that the teacher will do additional reading prior to teaching the unit. If possible, the introductory statement may be copied and distributed to students as reading material for reinforcing classroom instruction.

3. General Objectives

The general objectives of the unit are tabulated in this section. Here are stated ways in which students doing the unit are to be affected.

4. Concepts

The major generalizations or subject matter to be learned are tersely stated in this section.

5. Resources or References

In this section, the materials and equipment for the lessons in the unit are listed.

6. Correlation

Environmental education is obviously interdisciplinary in nature. It is easy, therefore, to relate sections of the programme to subjects taught at the upper secondary school level. The section on correlation is intended to help the teacher to identify those subject areas to which that aspect of environmental education may be related and as part of which it may be taught. The latter comment takes full cognizance of the current 'over-crowded curriculum' of many secondary schools.

7. Lesson Plans

Lesson plans suggest ways in which various aspects of the unit may be taught. Teachers are invited to make modifications as they see fitting. Each lesson plan is divided into the following areas:

(i) Specific objectives: what students should be able to achieve by the end of the lesson.

(ii) Learning activities: Teacher and student activities which should help student to achieve the stated objectives. It is expected that group work will be encouraged for as many of the learning activities as possible.

(iii) Assignment: To be done in class or at home depending on the nature of the assignment and the pace of the lesson.

(iv) Evaluation: How teachers should evaluate students to ascertain the extent to which the stated objectives were achieved.

8. Appendix

The appendix contain maps and other resource material which the teacher is otherwise likely to find extreme difficulty in securing.

UNIT I

THE ENVIRONMENT AND ENVIRONMENTAL CONSERVATION

THE ENVIRONMENT AND ENVIRONMENTAL CONSERVATION

Introductory Statement

Environmental Education allows us to examine our environmental and human problems from an ecological viewpoint. It helps to provide a factual basis on which action to improve the environment can be taken.

'Environment' in this context refers to the human environment, broadly defined as the existing natural resource base and man's modifications to it. Natural resources may be conveniently divided into two general categories - renewable resources and non-renewable resources - even though the distinction between these two types of resources has become blurred with increased knowledge and understanding of the environment. The terms therefore bear some limitations in usefulness. Generally, though, non-renewable resources are nonliving resources such as minerals and fossil fuels, while renewable resources are biotic resources including plants and animals.

One important distinction between biotic and nonliving resources is that biotic resources are able to reproduce or replace themselves and to increase. A nonliving resource does not replace itself, or rather does so at such a slow rate that it is not useful to consider it renewable in terms of human lifetimes. Once a nonrenewable resource is consumed, we must find a substitute or do without it. This may be said for iron ore, bauxite, or petroleum, which are all non-renewable resources.

It is thus essential to emphasize good management, wise use, and the avoidance of waste of non-renewable resources. Good management is also

important for living or biotic resources. In a forest which is properly managed, timber may be cut from it year after year without destroying it. With good management of agricultural soil, the land can yield crops for thousands of years. There is a need for conservation of both renewable and non-renewable resources.

The word 'conservation' has different shades of meaning. Here it is used to mean the rational use of the environment to provide a high quality of living for mankind. It involves both planning and control of man's use of the environment. In the struggle for the conservation of our environment we attempt to guarantee food and shelter for current and future human population and also attempt to guarantee those other qualities that enrich life--for example, space to move in, open and wild lands to roam, wild and natural scenery to admire, wild animals to watch, study or hunt. We even attempt to blend the natural and man made things to provide mutually enhancing beauty.

It is important that we have a knowledge of the ecological principles that control the functioning of our environment, since how we treat our environment will determine our future as human beings. There is, therefore, a strong need for environmental education.

General Objectives

Students should be able to:

(i) state the meaning of the term 'environment.'

(ii) state the meaning of the term 'conservation.'

(iii) recognize the need for conservation of renewable and non-renewable resources.

(iv) appreciate the need for conservation of the environment.

Concepts

(i) 'Environment' refers to the existing natural resources and man's modifications to them.

(ii) 'Conservation' is the rational use of the environment to provide a high quality of living to mankind.

(iii) Natural resources may be divided into two categories - renewable and non-renewable resources.

(iv) Renewable resources are living or biotic resources.

(v) Non-renewable resources are non-living things such as minerals and fossil fuels.

(vi) Our future level of survival will be determined by the way in which we treat our environment.

Resources and References

(i) Dasmann, R. F., Environmental Conservation. New York: John Wiley & Sons, 1972.

(ii) Up the OPEC Staircase. Newsweek, April 9, 1979, pp 34-35.

(iii) Petroleum - The Fuel of Modern Man. In C. Sibley and R. Turvey, The How and Why Wonder Bood of Energy and Power. London: Transworld Publishers, 1976, pp. 37-39.

Correlation

(i) Geography

(ii) Social Studies

(iii) Agricultural Science

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) explain the meaning of the term 'environment.' (ii) distinguish between renewable and non-renewable resources.	(i) Students should say what they understand by the term 'environment.' (ii) Different responses should be written on chalkboard. (iii) Teacher should use student responses to discuss the concept of 'environment.' (iv) Students should be asked for examples of natural resources. (v) Teacher should classify examples into two groups - renewable and non-renewable resources. (vi) Students should state the similarity among items in the same group and the differences between the two groups of items. (vii) Teacher should label groups and elaborate on the meaning of renewable and non-renewable resources.	(i) Students should write a clear statement on the meaning of the term 'environment.' (ii) Students should write a clear statment on the distinction between renewable and non-renewable.	Teacher should appraise statements written by students.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) explain the meaning of 'conservation.' (ii) explain the meaning of the term "environmental conservation."	(i) Students should say what they understand by the term 'conservation.' (ii) Different responses should be written on chalkboard. (iii) Teacher should use student responses to discuss the concept of conservation. (iv) Teacher should write the term 'environmental conservation' on chalkboard. (v) Students should say where they have encountered the term used before and in what context. (vi) Teacher should use student responses to clarify the meaning of the concept of "environmental conservation." (vii) Teacher should write a statement explaining the meaning of "environmental conservation." (viii) Student should do assignment (i), then write teacher's statement in notebook.	(i) Students should write a clear statement on the meaning of 'conservation.' (ii) For homework, students should write at least two reasons why environmental conservation is necessary.	(i) Teacher should appraise assignment (i) (ii) Teacher should appraise response to assignment (ii) for indication of understanding of concept of 'environmental conservation.'

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) recognize the need for conservation of renewable and non-renewable resources. (ii) appreciate the need for environmental conservation.	(i) Each student should read the two reasons he found to support the need for environmental conservation. (see assignment ii, Lesson 2) (ii) Teacher should list on chalkboard the various reasons reported. (iii) Teacher should use the list to emphasize the need for environmental conservation.	Student should list some of the things they can do to help conservation of the environment.	Teacher should appraise assignment.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to identify topical issues related to conservation.	(i) Teacher should get students to state some current local, regional, or international problems related to conservation issues. (ii) Teacher should briefly disucss each issue with students and help them to focus on the issue of the energy crisis and the need to conserve various forms of energy. (iii) Renewable and non-renewable sources of energy should be discussed. (iv) Students should state various non-renewable and renewable sources of energy used in Barbados.	Students should collect reports from newspapers and magazines on problems, emphasizing the need for proper management of the environment.	

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to recognize the conservation implications of the energy crisis in general and the oil crisis in particular.	(i) Students should read articles on "Petroleum, the Fuel of Modern Man" and article on "Up the OPEC Staircase" as well as their clippings. (See assignment in previous lesson.) (ii) Teacher should ask students to list the conservation issues raised in each of the articles. (iii) The issues listed by individual students should be presented to the rest of the class and a master list of issues compiled on chalkboard. (iv) Teacher should use the points listed to emphasize the need for conservation of energy in general and petroleum in particular.	Students should write a short essay on measures for proper management of the world's petroleum resources in the prevailing energy crisis.	Teacher should appraise assignment.

UNIT II (a)

SOIL - EROSION AND CONSERVATION

UNIT II (a) SOIL - EROSION AND CONSERVATION

Introductory Statement

Soil is a precious natural resource, the more so to the small island states of the Caribbean which are constantly buffeted by the wind and sea, and are also dependent on agriculture for economic security.

The loose material covering the land areas of earth may be hundreds of meters deep before rock is encountered. However, only that part of this material which can be penetrated by living organisms is regarded as soil. Soil may therefore be defined as a system in which energy and matter, from the sun and the atmosphere, and living organisms penetrate and interact.

Many forms of matter and energy make up the system:

(i) The land mass, which contributes rocks and mineral fragments; chemical compounds are absorbed at the surfaces of the fragments.

(ii) The atmosphere, which contributes water, carbon dioxide, oxygen and nitrogen.

(iii) Living organisms, which contribute energy obtained from sunlight (during the process of photosynthesis) and stored in carbon compounds.

In the soil these various forms of energy and matter interact as they meet, and either become changed in form or are moved about. Many of the changes are cyclic or alternating in nature. For example, to build the energy-rich carbon compounds they need for growth and other life processes, plants must have energy (from the sun), carbon dioxide (from the air) and water (chiefly from the soil). Through their dead parts, plants enrich the soil with organic matter. But for this organic matter to be released, microorganisms must decompose the dead plant material. In this way, carbon dioxide, water, nitrogen and energy are returned to the system.

Soil, with all its changes and interaction between energy and matter (both living and non-living), is a vital part of man's physical environment and man utilizes it to supply his needs.

He uses it to grow plants to feed himself and animals. In addition, he alters the soil by introducing new plants, by adding chemicals, by adding water by irrigation, or by removing water through drainage. He also builds homes, roads and other structures on or in the soil. His drinking water supply comes either from water that has been stored in the soil or from water than has passed through or run off it.

By using the soil, man is constantly altering his environment. He therefore needs to consider seriously the extent to which such uses or alterations improve or degrade the environment.

UNIT II (a) SOIL - EROSION AND CONSERVATION

General Objectives

Students should be able to:

(i) discuss the origin of soil and list factors which influence soil formation.

(ii) name the main components of various types of soil.

(iii) infer the various functions of soil components.

(iv) demonstrate the physical properties of soil types - sand, loam, clay.

(v) name the main groups of living organisms in the soil.

(vi) describe the role of living organisms in the soil.

(vii) describe how nutrients are recycled in the soil.

(viii) discuss the causes and consequences of soil erosion.

(ix) evaluate the soil as an important natural resource.

(x) appreciate the need for proper soil management and soil conservation.

(xi) appreciate the role of individuals, governments and international bodies in maintaining and conserving soil.

Concepts

(i) The soil is a natural resource as well as an ecosystem in which there is a continuous as well as balanced interaction between matter, living and nonliving, and energy.

(ii) The soil must be carefully utilized and managed by man so that the balance between interacting and nonliving components is maintained.

(iii) The visible effects of soil erosion are a result of man's activities.

Resources and References

(i) Fairbairn, P. A World Without Trees? Caribbean Contact, Aug. 1982, Vol. 10, No. 4, p. 15. (Appendix I).

(ii) Farrell, F.F. So Green Our Forests. Trinidad Naturalist, 1980. Vol. 3, No. 4, pp. 52-56.

(iii) Gooding, E.G.B. Soils of Barbados. Plant Communities of Barbados, pp. 22-23. Biological Factors. Plant Communities of Barbados, pp. 23-25.

(iv) Hilton, A. The Dollars and Cents in Forests. Trinidad Naturalist, 1980, Vol. 3, No. 4, pp. 48-51.

(v) Phillips, W. Save the Soil. The Nation, Aug. 20, 1980, p. 12.

(vi) Senn, A. Report on Geological Investigations of the Ground Water Resources of Barbados, B.W.I., 1946, pp. 7-8.

(vii) *Film Strips

Using our Forest Wisely	Ag 39
Using our Minerals Wisely	Ag 41
The Battle against Erosion	Ag 44
Soil Conservation - How Soil is Formed	Ag 46
How Man Conserves the Soil	Ag 47
Soil Conservation - Minerals in the Soil	Ag 49
Soil Conservation - Plant Life in the Soil	Ag 50
Water and the Soil	Ag 48
Conserving our Natural Resources - Saving our Soil	Ag 51
What is Conservation?	Ag 52
Soil Conservation - Animal Life and the Soil	Ag 55
How Long Will it Last?	Ag 56

Note: * Available at Audio Visual Aids Department, Ministry of Education and Culture, Barbados.

Correlation

(i) Integrated Science

(ii) Agricultural Science

(iii) Biology

(iv) Social Studies

(v) Geography

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) state at least five reasons why study of the soil is important. (ii) list basic information needed about soil.	(i) Students should read Introduction to this unit on soil and should then be asked to answer questions such as: (a) How is soil defined in this 'introduction?' (b) Why is soil called an ecosystem? (c) In what ways is the soil utilized by man? (ii) Students should write brief responses to questions in their notebooks. (iii) Students should devise questions they think relevant, that they will ask and try to answer when undertaking a study of the soil. (iv) Students should write questions on chalkboard and arrange them in sequence. (v) Students should copy questions in their notebooks.	See Learning Activity (ii).	Note pupil participation in the discussion. Check summaries for general organization of information.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to state differences between rocks and minerals.	(i) Draw students' attention to question written on chalkboard: that is, "What is the parent material of soil?" (ii) Point out that this lesson's activities will help provide answer to the question. (iii) Display various labelled mineral specimens on a table. (iv) Ask students to do the following with specimens: note colour, presence of air spaces etc., use hand lens to look closely at specimens, rub each specimen across a piece of porcelain tile and note colour of streak. (v) Ask students to state where minerals occur naturally. (vi) Ask if only one type of mineral would be found in rocks. (vii) Get the students to suggest differences between rocks and minerals.	Students should (i) record observations using columns headed: mineral, colour, colour of streak. (ii) name important minerals found in Caribbean countries.	Note interest shown by students when carrying out activities. Check written recordings for accuracy and clarity.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to classify rocks on the basis on which they are formed.	(i) Discuss origin and formation of igneous, sedimentary and metamorphic rocks. (ii) Display coloured pictures or actual rock collection of at least three examples of named igneous rocks, sedimentary rocks, and metamorphic rocks. (iii) Collect rocks from any area and try to identify and classify them. (iv) Display rock collection in classroom.	Encourage students to start rock collection. Collection should have information such as where rock was found, when found and general description. Students should collect information from encyclopaedia on igneous rock, sedimentary rock, metamorphic rocks.	Note how well students can communicate their ideas verbally. Check written assignment to see how effectively students can use encyclopaedia.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to describe rock formations in Barbados generally.	(i) Use map to show geological structure of Barbados. (ii) Read The Coral Rock Formation in its function as permeable rock; p. 7 of Geological Investigations of the Ground Water Resources of Barbados, B.W.I., by Senn. (iii) Also read pp. 9-12 of Plant Communities of Barbados by Gooding. (iv) Arrange for a visit to places such as Gun Hill, Golden Grove Ridge in St. George, Rendezvous Ridge, Ragged Point in St. Phillip.	Students should write short essay on Coral rock cap of Barbados.	Check written assignments to assess how well students can arrange ideas.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to explain and give examples of physical weathering processes (disintegration).	(i) Encourage students to suggest how soil is formed from its parent material. (ii) Practical activities should be done by students to show effects of heating, cooling, wetting, freezing on different types of rocks. (iii) Ask student to relate observed effects of weathering of rocks by sun, rain, snow, etc.	Write up activity (iii) in books. Read page 12 in Gooding, Plant Communities.	Check written work to note students' accuracy of observation, and explanation of those observations.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to explain and give examples of chemical weathering processes (decomposition).	(i) Simple activities to be done by students to illustrate the following chemical reactions: (a) Oxidation - oxidation of ferrous oxide to ferric oxide. (b) dissolving - water-soluble minerals dissolve in the soil water. (c) carbonation - reaction between soda water (carbonic acid) and limestone which has been soaked in water for a long time. Chemical equation: $CaCO_3 + CO_2 + H_2O \rightleftarrows Ca(HCO_3)_2$ Ask students to relate observed effects with chemical decomposition in rocks.	Students should (i) record activities done. (ii) give other examples of these types of chemical reactions.	Appraise students' written responses for accuracy and general understanding of the scientific principles involved.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to explain and give examples of biological weathering processes.	(i) Get pupils to explain how plant roots split rocks, and how burrowing animals can also help in the mixing of soil and breaking of rocks. (ii) Class should proceed to look around surroundings for plant roots cracking concrete fence and for evidence of animals mixing soil and breaking rocks.	Students should list agents of soil erosion and explain how each agent causes erosion.	Note how pupils work together in groups. Check assignment for accuracy and presentation of ideas.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to name and describe the layers of a soil profile.	(i) Dig a fairly deep hole in school ground to show a section through the soil. (ii) Ask students to describe appearance and structure of profile. (iii) Get students to examine each layer for presence of roots and living organisms and to note how layers (horizons) change from parent rock to loose top soil.	Students should draw soil profile and label each layer.	Check diagrams for labelling and for neatness. Assess how well pupils can explain verbally their observations.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to list and note physical characteristics of components of soil.	Carry out the following experiment to compare mineral particles of soil with soil samples taken from different locations. (a) Get some dry soil, remove stone, and crush soil to break up the crumbs. (b) Place about 50 gm. of soil in measuring cylinder or large beaker. Add large amount of water and shake or stir mixture. (c) Allow contents to settle, tell students to note which particles settle first. (d) Mark boundaries (on outside of container) between layers. Repeat using other soil samples, making sure that same weight of soil, same volume of water, and container of same capacity are used.	Students should draw up task with the following subheads: (a) Components of soil. (b) Sources of soil components. (c) Function of soil components.	(i) Teacher should collect assignment and note how well students understand functions of soil components. (ii) Teacher should assess how well pupils work with one another in group activities.

UNIT II (a) SOIL - EROSION AND CONSERVATION LESSON 10

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to note and list physical characteristics of the components of soil.	Students should design their own experiment to find out the following: (a) Weight of water in samples of soil. (b) Weight of humus in the soil. (c) Volume of air in the soil. (d) Permeability of soils to water.	Students should: (i) read section on The Soils of Barbados, pp.22-23 in Plant Communities of Barbados. (ii) write up investigation in notebooks.	Discuss reading assignment. Note how students draw on their own observations of the physical environment.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Student should be able to name the main groups of living organisms in the soil.	(i) Have students go into school yard or garden, dig up some soil and note all living things seen. (ii) Take some soil to classroom and check it for presence of micro-organisms as follows: (a) Examine soil sample with a hand lens. (b) Spread some of soil sample onto nutrient agar in Petri dishes. (c) Set up control, i.e., agar in Petri dishes with no soil. (d) Leave for a few days and observe. (iii) With the aid of diagram on nitrogen cycle, discuss the role of micro-organisms in recycling of nutrients in the soil.	(i) Students should answer these questions: (a) Why was there need for a control? (b) Why was agar used?	(i) Assess written assignments for understanding of scientific concepts and scientific method. (ii) Check assignment for neatness, clarity and accuracy of ideas.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) define soil erosion (ii) cite examples of soil erosion.	(i) Elicit from students that man's use of soil has lead to the serious problem of accelerated soil erosion. (ii) Have students walk around school compound to note instances of soil erosion. (iii) Get students to give examples of soil erosion in their neighborhood. (iv) Have student recall how places, subjected to water runoff, look after a heavy rainfall. Let them comment on things such as colour of running water, speed with which the water runs, appearance of debris and rocks on the road. (v) Display pictures and show film strip of soil erosion. (vi) Ask students which part of Barbados has a serious problem with soil erosion. Provide answer if students do not know. (Scotland District in St.Andrew). (vii) Read pp. 58-59 of Senn's Geological Investigation of Ground Water Resources in Barbados. (viii) Arrange for visit to Scotland District to look for: (a) areas which are talus slope or scree as mentioned by Senn. (b) areas where landslides have occurred. (c) alluvial deposits. (ix) Display on bulletin board article "Save the Soil" by W. Phillips.	(i) Students should get information on occurrences of land slides in Barbados. (ii) Teacher should ask students to write reports following visit. See activity (viii).	Note how pupils relate information contained in readings to their own observations.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) describe how a land slide occurs. (ii) describe how wind erodes soil.	(i) Use tray with soil in it and set tray at angle; i.e., put it in a sloping position. (ii) Lead rubber trip from tap to soil and allow water to flow through base of soil to illustrate the effect of moving water on soil. (iii) Relate this observation to actual effect of streams and rivers on soil. (iv) Show film strip, Conserving our Natural Resources - Saving our Soil. (v) Arrange visit to beach to see effects of soil erosion by the sea. (vi) Point out to students that wind is another agent of erosion and slides. (vii) Show pictures of deserts and sand dunes and relate to erosion by wind.	(i) Students should write up activities (i), (ii) and (iii) in notebooks. (ii) Get pupils to describe orally effects of high winds and heavy rainfall during a hurricane.	Assess student awareness of problem of erosion through question asked, observations made, etc.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to identify ways in which man's activities are speeding up soil erosion.	(i) Stress to students that the principal precondition of soil erosion is the degeneration or removal of natural vegetation through deforestation, overgrazing, burning, cultivation and construction. (ii) Read article in Contact, 'A World Without Trees.' Post this article on bulletin board. (iii) Refer also to articles in Trinidad Naturalist Vol. 3, No. 4, 'The Dollars and Cents in Forests.'(p.48) and 'So Green our Forests.'(p.52).	Students should (i) Write two paragraphs on effects of soil erosion on human welfare. (ii) Read pp. 23-25 in Gooding's Plant Communities of Barbados (section on 'Biological Factors').	Check written work for clarity of ideas, understanding of problems caused by soil erosion.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to list the corrective measures that are used to prevent or slow down soil erosion.	(i) Show film strips: (a) How Man Conserves the Soil (b) Soil Conservation - How Long Will it Last? (ii) Display pictures of contour ploughing, strip cropping, terracing, wind breaks, etc. (iii) Visit a nearby farm and observe methods used to conserve and improve top soil. Arrange visit, and report on services offered by Soil Conservation Unit in Barbados.	Students should briefly describe ways in which soil erosion can be prevented.	Assess answers for understanding of methods used to prevent soil erosion.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) recognize that soil erosion and conservation is an international problem. (ii) note how man is expressing concern for the problem of soil erosion.	(i) Ask questions about what mankind is doing about the world-wide problem of soil erosion. (ii) Display section on 'Desertification' in Courier No. 47 Jan - Feb 1978, as well as United Nations documents on Conservation. (iii) Use these resource materials to generate discussion on role of individuals, groups, governments and international bodies in dealing with the problem of soil erosion.	Students should find out if there are any laws in Barbados on Conservation. Find out names of groups concerned with problems such as soil conservation.	Assess assignments and oral discussion for pupils'awareness of the need to conserve and the need to manage environment wisely.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to recognize that they also have a part to play in soil conservation.	(i) Present students with situations involving soil erosion, and get them to apply knowledge acquired so far on soil erosion, to solve the problem. One such situation may involve a farmer planting on a steep hillside and who therefore needs to prevent soil from being washed away. (ii) Walk around school yard and note areas where erosion is taking place. (iii) Recommend corrective measures. (iv) Encourage students to carry out some of these corrective measures.	Design an experiment to show effects of mulch layer and humus on soil structure and its water retention ability.	

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to recognize that they also have a part to play in soil conservation.	(i) Have a recap of the whole discussion on soil. (ii) Encourage groups of students to put together description of activities and field trips as well as collection of pictures, clippings from papers and magazines and have a display mounted for other students. Title of display could be 'Soil Erosion and Conservation.' (iii) Arrange a debate or panel discussion on the topic "Which is more important, conservation or development?"	Students should produce written responses to the following questions: (a) How useful do you feel the unit on soil was? (b) What is the relationship between flooding, drought, and clearing away of vegetation? (c) What problems do governments face when making decisions between development and conservation?	Appraise student responses to see how aware they are of the problems of soil management.

UNIT II (b)

LAND - USE AND MISUSE

UNIT II (b) LAND - USE AND MISUSE

Introductory Statement

Land constitutes an indispensable basis for human settlement and survival. The first step towards sound land use is proper land classification. Based on suitability derived from such classification, land provides for, or accommodates, a variety of human use including agricultural, industrial, commercial, transportation and housing.

It is widely acknowledged that the most serious problem in land use management is the utilization of land according to its capabilities. Throughout the world, for example, can be found marginal-land farmers who attempt to squeeze a living from land not suited to crop production, ruining the land in the process. Such practices damage the land and lead to environmental problems such as those related to soil erosion. They lead as well to the production of poor crops.

In response to the need for proper classification of land to guide proper land use, the United States Soil Conservation Service has developed a detailed classification system (See Appendix). This classification system should have high utility value for most regions of the world, including the Caribbean. Other, more specific types of classification better suited to a particular territory may, of course, be developed using the classification scheme of the United States Soil Conservation Service as a starting point.

Crucial to appropriate land classification and use is the recognition that single-purpose use of extensive areas can hardly be afforded today. It will be conceded that crop production and such farming use precludes the possibility of other land uses for most of the year. However, even

among the best farmlands there are many small areas, at least, not suited to crop production. These areas deserve to be properly managed and utilized. Properly managed, they can provide recreation space, retreats for some forms of wildlife or simply add to local beauty of the landscape. On the other hand, if not given proper attention, such areas may be indiscriminately used as dumping grounds, adding to pollution of the environment, creating an untidy and depressing appearance where flies and mosquitoes breed, and in general prescribing a serious health hazard.

Non-agricultural lands are often suited to more than one purpose. In such lands one may easily find evidence of compatible as well as conflicting land use.

UNIT II (b) LAND - USE AND MISUSE

General Objectives

Students should be able to:

(i) recognize that appropriate land use depends on the physical characteristics of the land.

(ii) identify areas of misuse of land.

(iii) identify possible conflicts over use of land.

(iv) appreciate the need for proper management.

Concepts

(i) The capability of land should determine the type of use to which it is put.

(ii) Marginal-land farming damages the land and leads to soil erosion and poor yields.

(iii) Indiscriminate dumping of waste on land not identified for such purpose pollutes the environment, creates an untidy and depressing appearance, provides breeding ground for flies and mosquitoes, and in general presents a serious health hazard.

(iv) Multiple land use is a practice in which a given land area functions in two or more compatible ways.

(v) Single-purpose use of extensive land areas can no longer be afforded in most places.

(vi) It is frequently necessary to resolve conflicts arising from competing land use.

Resources and References

(i) Maps of Barbados

(a) Land Use Capability (Appendix C)

(b) Present Land use (Appendix D)

(c) Political

(ii) Klingebiel, A. A. & Montgomery, P. H. Land - Capability Classification. U.S. Department of Agriculture Handbook No. 210, 1976, pp 6-10. (Appendix E).

(iii) A Land-Use Decision Making Situation (Appendix F)

(iv) Macpherson, J. Caribbean Lands. Longmans.

(v) Dasmann, R. F. Environmental Conservation, New York: John Wiley & Sons, 1972.

Correlation

(i) Geography

(ii) Agricultural Science

(iii) Social Studies

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) recognize that one area of land may be used for several purposes. (ii) recognize that land may be classified accoring to certain physical characteristics. (iii) recognize that different types of land are suited to different purposes.	(i) Students should state some of the uses to which land is put. (ii) Students should then state what special quality, if any, is required of the land for selected purposes. (iii) Teacher should summarize by pointing out that land may be classified according to certain physical characteristics. (iv) Teacher should discuss the classification scheme developed by the United States Soil Conservation Service (Appendix E). (v) Teacher should write on chalk board brief statements about each category of land and its primary and secondary uses. (vi) Students should copy teacher's summary in their notebooks.	(i) Students should study notes on the classification of land by the United States Soil Conservation Service.	Teachers should ask a few students to say what they learned from the lesson and use this as the basis for evaluation.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) state some of the major land uses. (ii) identify areas or parishes in Barbados with special land use capabilities. (a) state the current major land use in Barbados (b) identify areas or parishes in Barbados which are associated with the current major land use.	(i) Teacher should point out that the first step toward proper land use is proper land classification. (ii) Teacher should point out that for many countries such classification has been done and the capabilities of different areas have been noted. (iii) Students should look at map of major land use capabilities of various parishes (Appendix C). (iv) Students should examine map of actual land use and note parishes where such use is predominant (Appendix D). (v) Students should compare capabilities of land use and actual land use and to note discrepancies. (vi) Students should attempt explanation for the discrepancies.	Students should list parishes and state capabilities of land use and actual land use in each parish. If possible, more specific location in parish should be stated. Students should write summary of discrepancies noted.	Teacher should appraise student response to assignment.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) recognize the prevalence of multi-purpose use of land. (ii) recognize that such land use may be compatible or conflicting.	(i) Teacher should remind students that in the classification scheme discussed in first lesson primary and secondary uses of land were identified, indicating that land could be used for more than one purpose. (ii) Teacher should encourage students to identify a piece of land and state the various uses to which it is put. (iii) Students should say if there is any problem likely to arise from the use of the same piece of land for several purposes. (iv) Teacher should encourage classification of such land as that which demonstrates compatible land use and that which demonstrates conflicting land use. (v) Students should attempt to account for discrepancies noted in land use capability and actual land use in Barbados (see previous lesson.)	Students should write down their explanation for the discrepancies noted in the use of land (see Learning Activity (v).	Teacher should appraise response to assignment.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) identify ways in which land is misused. (ii) explain the consequences of such misuse of land.	(i) Students should state some ways in which areas of land are misused. (ii) Teacher should list those ways on chalkboard, adding to the list if necessary. (iii) Teacher should identify farming of marginal land and improper disposal of waste as two major ways in which land is misused. (iv) Teacher should help students identify marginal land and areas where evidence of improper disposal of waste is found. (v) The consequences of each of these practices should be discussed. (vi) The consequences of other ways in which land is misused should be discussed if time permits.	Students should list in their notebooks any two examples of the misuse of land and state preventive and corrective measures which may be taken in each instance.	Teacher should appraise assignment.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) recognize that conflicts are likely to arise between various interest groups over the use of land. (ii) appreciate the interplay of factors which determine the resolution of such conflicts. (iii) appreciate that there are often significant problems involved in making decisions concerning wise use of land.	(i) Teacher should adapt conflict situation over use of land (Appendix F) to satisfy local conditions. (ii) Students should be presented with the situation and encouraged to volunteer for various roles. (iii) Teacher should summarize salient points which emerge from role play in the conflict situation.		Students should express their views about the manner in which the conflict was resolved. This should provide the basis for evaluation.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) appreciate the need for multiple purpose use of land in Barbados.	(i) Resource person from Planning Section of Government Ministry should be invited to discuss with students the multi-purpose use of land in Barbados. (ii) Students should make note of important points raised by resource person. (iii) Students should also be encouraged to seek clarification of issues whenever the need and opportunity arises during the presentation of the resource person.	Students should prepare summary of points raised in the discussion by resource person.	Teacher should appraise on the basis of student response to presentation as evident by questions asked and comments made.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) report on the need for multiple use of land in Barbados. (ii) give examples of multiple use of land in Barbados. (iii) identify ways in which conflicting use of land is resolved in Barbados.	(i) Students should read reports summarizing major points made by resource person. (ii) Teacher should list important points on chalkboard. (iii) Students' attention should be drawn to the compatible and conflicting use of land and how some problems related to the latter are resolved by the appropriate Government department.		Student summary should provide basis for evaluation.

UNIT III (a)

WILDLIFE - DESTRUCTION AND PROTECTION

UNIT III (a) WILDLIFE - DESTRUCTION AND PROTECTION

Introductory Statement

Wildlife is one of the biotic resources of the environment. The term 'wildlife' is sometimes used in the broad sense to refer to both the fauna and flora of a territory and region. As the term is used by environmentalists, however, it usually refers to higher animals (including birds) in their natural environemnt. It is in this sense that the term is used here.

Wild creatures, like human beings, need to have certain basic requirements for their survival, including food, water and a place to live in and raise their offspring. Different creatures, of course, require different habitats.

Wildlife is an important element in maintaining the ecological balance. And too, for man, wildlife watching has for years been a source of recreation and education. Some species have also been for man not only a source of recreational hunting but also a source of commercial hunting.

It is well known that certain of man's activities have been increasingly threatening the survival of wildlife and have rendered some species extinct. This fact has motivated many national governments, private citizens and regional and international organizations to initiate programmes aimed at protecting threatened or endangered species.

It is fully recognized that recreational and commercial hunting has been responsible for the extinction of many species and for threatening and endangering others. Commercial hunting of tigers and leopards for their skin, and elephants for their tusks have considerably threated the survival of several of these species. Indiscriminate pleasure hunting, including

cases where the victims are not meant to serve any commercial or material purpose, has also contributed to the threat of survival for many species.

Just as serious a threat as the direct killing of wild creatures is the destruction of their habitat. In the face of modernization of communities, wildlife has suffered tremendously. The building of highways, for example, often necessitates the clearing of forests and other vegetation which form the natural habitat of wildlife. The building of dams and the flooding of larger areas to create reservoirs have also completely destroyed wildlife habitat. So too, have reclamation schemes involving the draining of wetlands for suburban or other development.

Many countries have responded to the threat posed to the survival of wildlife by implementing a number of conservation measures. Such measures include legislations to control hunting by placing restrictions on the means by which wildlife may be hunted, the species which may be hunted, and the time of the year when hunting is allowed.

With due regard to the need to protect the habitat of wildlife, several countries have also passed laws against the destruction of wildlife habitats. In some countries too, steps have been taken to reflood some of the previously drained wetlands.

UNIT III (a) WILDLIFE - DESTRUCTION AND PROTECTION

General Objectives

Students should be able to:

(i) explain the usefulness of wildlife to man.

(ii) identify ways in which wildlife is damaged by man's activities.

(iii) state measures which may be implemented for the protection of wildlife.

(iv) recognize the need to protect wildlife.

(v) identify areas in Barbados where endangered species have their habitat.

(vi) appreciate the need for protection of wildlife in Barbados.

Concepts

(i) Wildlife is one of the biotic resources of the environment. As used by environmentalists, the term refers to higher animals (including birds) in their natural environment.

(ii) Wildlife requires a supportive habitat for survival.

(iii) Wildlife is of recreational, educational and commercial value to man.

(iv) Human activities have continually threatened the survival of wildlife and have rendered some species extinct.

(v) Positive action needs to be taken for the protection of wildlife. Some countries have responded to this need by passing a number of protective laws.

(vi) Barbados, too, has wildlife which needs to be protected. It includes game birds, monkeys, yellow warblers, wading birds and migrating species.

Resources or References

(i) Colour pictures of wildlife.

(ii) Maps of Barbados

(a) Political

(b) Endangered and Locally Important Species (Appendix A)

(iii) Dasmann, R.F. Environmental Conservation. New York: John Wiley and Sons, 1972, pp. 275-302.

(iv) Jackson, O. Conservation and Pollution. London: B. T. Batsford, 1971, pp. 70-82.

(v) The Bajan. February, 1981, Articles, pp. 4-20.

Correlation

(i) Geography

(ii) Social Studies

(iii) Agricultural Science

(iv) Industrial Arts

(v) Integrated Science

(vi) History

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) explain the meaning of the concept of wildlife. (ii) recognize that wildlife requires a supportive environment for survival.	(i) Students should say what they understand by the term 'wildlife.' (ii) Teacher should use student response to help students develop an understanding of the concept of wildlife. (iii) Teacher should display color pictures of wildlife: for example, alligators, tigers, lions, wild ducks, game birds, turtles, to illustrate the meaning of wildlife. (iv) Student should state where each of the forms of wildlife displayed may be found. (v) Teacher should point out in summary that different forms of wildlife require different types of habitat. (vi) Teacher should guide students in a discussion on some of the common and specific requirements of the habitats of different forms of wildlife.	(i) Students should write a simple explanation of the meaning of wildlife and give examples of wildlife and their habitats. (ii) Students should research on various forms of wildlife found in Barbados.	Teachers should review response to assignment (i).

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) recognize that Barbados has its own assemblage of wildlife. (ii) identify different forms of wildlife in Barbados. (iii) locate different areas in Barbados where different major forms of wildlife are found.	(i) Students should report on the findings of their research. (Lesson 1, assignment (ii)). (ii) Teacher should use student findings to compile on the chalkboard a list of various forms of wildlife found in Barbados, adding to the list if necessary. (iii) Students should attempt to identify parts of Barbados in which some of the listed forms of wildlife are concentrated. (iv) Teacher should use map of endangered species and locally important species (Appendix A) to point out the parts of the island where these species have been found concentrated. (v) Students should use map of Barbados (political) and map of endangered and locally important species to locate the parish and areas within it where a specific species of wildlife is concentrated.	(i) Students should write down the location of various species of wildlife in Barbados.	Teacher should evaluate response to assignment.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) recognize the current danger posed to the survival of the cattle egret in Barbados. (ii) recognize ways in which the cattle egret may be protected.	(i) Students should study article on angroves of Graeme Hall Swamp by Deborah Riven - Ramsey, The Bajan, February, 1981. (ii) Teacher should direct students' attention to salient points with respect to (a) The habitat of the egrets, (b) How the species is endangered, and (c) Suggestions for protection of the species. (iii) Teacher should help students to clarify difficult points encountered in course of reading the article.	Students should make notes as they read article. Notes should be related to the three sections listed in Learning Activity (ii).	Teacher should ask a few oral questions based on the article, in particular on (a), (b) and (c) of learning activity (ii).

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) describe the habitat of cattle egrets in Barbados. (ii) give reasons for describing cattle egrets as endangered. (iii) suggest measures for the protection of cattle egrets in Barbados.	(i) Students should use their notes taken in Lesson 3 to discuss the cattle egret, its habitat in Barbados, its being endangered in Barbados, and measures for its protection. (ii) Teacher should summarize major points on chalkboard under sub-heads of (a) Habitat, (b) Danger, and (c) Protective Measures. (iii) Students should write notes from chalkboard in their notebooks.		Teacher should evaluate students on their contribution to the discussion.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) identify ways in which the endangered species of turtle in Barbados may be protected by individuals. (ii) appreciate the role they can play in preserving endangered species.	(i) Students should study the one-page article "A Turtle Form at the Crane" by Debra Hughes, The Bajan, February 1981. (ii) Teacher should discuss the article with students, emphasizing the role of man in helping to preserve endangered species. (iii) Students should be asked to suggest other measures which may be taken to protect turtles and other endangered species in Barbados.		Teacher should evaluate students on their contribution to the discussion.

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UNIT III (a) WILDLIFE - DESTRUCTION AND PROTECTION LESSON 6

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) explain the usefulness of wildlife to man. (ii) identify ways in which the indiscriminate use of wildlife by man has adversely affected some species.	(i) Students should state ways in which wildlife is useful to man. (ii) Teacher should elaborate on each of the uses stated and should add to the list if necessary. (iii) Teacher should initiate and guide a discussion on "Hunting - Its Good and Bad Sides." (iv) The concepts of 'endangered,' 'threatened,' and 'extinct' species should be introduced in the discussion.	For the next lesson students should research other ways in which the activities of man threaten wildlife.	Teacher should ask a few students to give an oral summary of what they learned from the discussion and evaluate the same.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) recognize that activities associated with modernization and development of communities often threaten the survival of wildlife. (ii) recognize that Barbados has threatened or endangered species of wildlife. (iii) Locate the areas where threatened or endangered species are found in Barbados.	(i) Students should report on their findings (See previous lesson). (ii) Teacher should list on chalkboard student findings on essential ways in which the activities of man threaten wildlife, adding to the list if necessary. (iii) Students should be encouraged to name additional endangered species found in Barbados. (iv) Students should use Barbados map of endangered and locally important species (See Appendix A), and map of Barbados - political, to determine the exact location of endangered species found in Barbados.	(i) Students should list in their notebooks ways in which the activities of man threaten the survival of wildlife. (ii) Students should write in their notebooks the names of additional endangered species found in Barbados and their exact location.	Teacher should appraise student response to assignments (i) and (ii).

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to identify measures which may be taken for the preservation of wildlife.	(i) Teacher should present students with a problem in which a developing community suffers from all the ills which may eradicate its wildlife. (ii) Students should say what measures they would implement, if given the authority, to correct the ills and to prevent further damage to wildlife. (iii) Teacher should list these measures on chalkboard, adding to the list if necessary. (iv) Students should say which of the measures they would suggest for preventing further threats to endangered species in Barbados, how such measures may be initiated, and the chances of success.	(i) Students should prepare for a 'mock' television interview on 'Preservation of Wildlife in Barbados.' Some students should prepare the questions to be asked, others should consider responses to questions which may be asked.	Teacher should appraise student response to activity (iv) as an indicator of extent to which the objective of the lesson was achieved.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to suggest measures for the preservation of wildlife in Barbados.	(i) Students should simulate a television interview with one interviewer and three or four interviewees taking part in each session. (ii) Sessions may be recorded and subsequently replayed for student appraisal. (iii) Teacher should summarize major points which emerge from simulated interviews.	During each session students should appraise the interviewer and panel of interviewees. Grades or points may be awarded under guidelines given by the teacher.	Learning activities should provide the basis for evaluation.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to appreciate the role of the Caribbean Conservation Association and other agents in promoting proper care and use of environmental resources.	(i) Students should read articles on Barbados and the Caribbean Conservation Associaton. (ii) Students should take notes on salient points about the role of the Conservation Association. (iii) Teacher should guide a discussion on the role of the Caribbean Conservation Association in Barbados. (iv) Students should name private individuals as well as organizations and institutions which play an important role in promoting proper care and use of the environment.	Students should list persons, institutions and organizations named in Learning Activity (iv).	Teacher should appraise student assignment.

UNIT III (b)

VEGETATION - IMPORTANCE, DESTRUCTION, AND CONSERVATION

UNIT III (b) VEGETATION - IMPORTANCE, DESTRUCTION AND CONSERVATION

Introductory Statement

Forests and other vegetation are all renewable or biotic resources. For early man these resources were extremely important. Plants, trees and forests provided him with fuel, furniture, tools and food.

The presence of vegetation is important to our environment. The roots of trees and plants help to bind and protect the soil and keep it in place. Vegetation thus helps in controlling the rate of soil erosion and is invaluable to soil conservation.

By keeping the soil together vegetation allows it to act as a sponge regulating the movement of water in the area. Vegetation protects waterbeds and ensures good infiltration of water to underground aquifiers and a high sustained yield of fresh water to rivers and streams with a minimum of siltation.

Forests and other vegetation have various types of wildlife and provide the necessary support for their continued survival. They also help to maintain a balance of gases in the atmosphere by taking in carbon dioxide through their leaves primarily in the daytime and using it in a process called photosynthesis, to make for the plant food substances such as sugar and starch. During this process, trees and plants give off oxygen. Thus, trees and plants help to get rid of some of the carbon dioxide continually produced by human and animal respiration and by other activities in the environment, and help to replace the oxygen used up during those activities. Massive destruction of trees and plants therefore may affect the atmospheric balance of gases.

Trees, plants and other vegetation may contribute to the aesthetic quality of our environment. They may provide, too, a source of public recreation, education and research. It is important then that such vegetation be properly managed.

Forests are a well-known source of timber used for the construction of buildings and bridges, the manufacture of furniture and a number of other purposes. Indiscriminate logging, however, may contribute to deforestation of large areas, leading to the disruption of waterbeds, the erosion of soil, its loss of fertility, the siltation and flooding of streams and coastal bays, and loss of water available for recharging ground aquifiers. Such indiscriminate logging has also been responsible for the destruction of natural habitats and the species which occupy them.

Today, many countries are taking measures to conserve forests. Programmes of reforestation have been started in several countries in order to remedy the damage done to some forests. In fact, more and more countries are today implementing measures to protect their trees and plants in general.

UNIT III (b) VEGETATION - IMPORTANCE, DESTRUCTION, AND CONSERVATION

General Objectives

Students should be able to:

(i) state the importance of vegetation to the environment.

(ii) recognize that there is natural vegetation as well as vegetation created through human intervention.

(iii) identify major types of vegetation in Barbados.

(iv) identify ways in which forests and other vegetation are destroyed.

(v) identify measures for conservation of forests, trees, and other vegetation.

(vi) appreciate the need for conservation of forests, trees and other vegetation.

Concepts

(i) Vegetation may be divided into natural vegetation and vegetation created through human intervention.

(ii) Because of the variation in soil and climate conditions, the natural vegetation in the Caribbean varies from place to place.

(iii) The natural vegetation in Barbados may be classified as mangrove, littoral vegetation, cactus scrub, dry woodland, and moist forest.

(iv) In order to obtain fuel, obtain building material, and clear the land for cultivation and various other activities, man has removed a lot of natural vegetation, leading in many places to its replacement with secondary vegetation, that is, some degenerate form of the original vegetation.

(v) Man had also deliberately planted trees and plants as measures to aid soil conservation, for recreational and aesthetic purposes, and to provide food.

(vi) Vegetation is important to the environment for the protection of soil and watersheds, for ensuring good infiltration of water to underground aquifiers, and for sustaining the yield of fresh water to rivers and streams with a minimum of siltation.

(vii) Forests and other vegetation house various types of wildlife and provide the necessary support for their survival.

(viii) Forests and other vegetation help to maintain a balance of gases in the atmosphere.

(ix) Destruction of forests and other vegetation can have serious consequences for our environment.

(x) Several measures can be taken to conserve forests and other vegetation.

References and Resources

(i) Maps of Barbados

(a) Political

(b) Terrestial Life Zones (Appendix B)

(ii) Diagrams showing watershed, underground aquifiers, rivers, streams and their sources.

(iii) Macpherson, J. Caribbean Lands: A Geography of the West Indies. Longman's.

(iv) Williams-Bailey, W. and Pemberton, P. H. Nelson's West Indian Geography. Middlesex: Thomas Nelson, 1972, pp 24-26.

(v) The Bajan, February, 1981, pp. 4-7.

Correlation

(i) Geography

(ii) Social Studies

(iii) Integrated Science

(iv) Agricultural Science

(v) Home Economics - Food and Nutrition

(vi) Photography

(vii) Art

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) explain the meaning of the concept of vegetation. (ii) differentiate between natural vegetation and vegetation occurring through human intervention.	(i) Students should use their dictionaries to find the meaning of 'vegetation.' (ii) Students should give examples of vegetation occurring in Barbados. (iii) Teacher should write examples on chalkboard classifying them into to categories-natural vegetation, and vegetation created through human intervention. (iv) Students should state the similarities among the examples of vegetation within groups and the differences between groups. (v) Teacher should use student response to clarify the concept of vegetation and to help students distinguish between natural vegetation and vegetation occurring through human intervention. (vi) Teacher should initiate discussion on the concept of secondary vegetation.	(i) Students should list in their notebooks examples of natural vegetation and examples of vegetation arising out of human intervention. (ii) Students should write a few sentences explaining how secondary vegetation arises. (iii) Students should research for next lesson the types of natural vegetation found in the Caribbean and the areas in which they occur.	Teacher should appraise student response to assignments (i) and (ii).

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) identify the major types of natural vegetation found in the Caribbean. (ii) state the factors responsible for variation in the types of vegetation found in the Caribbean. (iii) match different types of soil and climatic conditions.	(i) Students should report on their findings about the types of natural vegetation found in the Caribbean and the areas in which they are found. (ii) Students shall be encouraged to describe vegetation and areas in which they are found rather than to label them. (iii) Teacher should write down on chalkboard the names given to the different types of vegetation and to the areas in which they are found. (iv) Teacher should use student responses to further clarify the types of natural vegetation and the areas in which they are found. (v) Students should identify two major conditions which determine the type of vegetation found in the different areas.	(i) Students should complete a matching exercise where they match type of natural vegetation with type of area. (ii) For the next lesson, students should research the types of natural vegetation found in Barbados.	Teacher should appraise student response to assignment (i).

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) identify the types of natural vegetation found in Barbados. (ii) Locate, on a map of Barbados, the areas where each of the different types of vegetation are found.	(i) Students should report on their findings about the types of natural vegetation found in Barbados. (ii) Teacher should list each type of vegation on chalkboard, adding to the list if necessary. (iii) Using maps of Barbados - Terrestial Life Zones (Appendix B), and Barbados-Political, students should identify the parishes in Barbados and the places in those parishes where each type of natural vegetation is found.	(i) Students should should use the classification of different types of natural vegation found in the Caribbean (Lesson 2, Assignment (ii)) to match the types of vegetation identified in Barbados with the types of areas in which they should be found. (ii) Students should list the types of natural vegetation found in Barbados and the parishes in which they are found.	Teacher should appraise student response to assignments (i) and (ii).

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) recognize that natural and secondary vegetation protect the soil. (ii) recognize that plants and trees which are deliberately planted aid in soil conservation. (iii) explain how vegetation as a whole helps to maintain the balance of gases in the atmosphere.	(i) Students should be asked to imagine that Barbados had all its vegetation removed and to state the consequences which they feel this would have for the soil and the atmosphere. (ii) Teacher should use student responses to reinforce the point that natural and secondary vegetation protect the soil. (iii) Teacher should draw attention to similar protection offered by trees and plants deliberately planted. (iv) Teacher should explain (with the aid of diagrams on chalkboard if necessary) how plants, through the process of photosynthesis, help to maintain a balance of gases in the atmosphere.	Students should prepare for a field trip to local forests and parks. Teacher should encourage students to take along notebooks, pens, pencils, sketch pads, colouring sets, and cameras.	Students are to repeat Learning Activity (i) at the end of the lesson, using points which emerge from discussion during the lesson.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) appreciate the recreational and aesthetic value of natural vegetation, especially forests. (ii) appreciate the recreational and aesthetic ends which may be satisfied by the planting of trees and plants.	(i) Teacher should outline the places to be visited and the main points to be observed. (See Lesson 4, assignment.) (ii) Students should make notes during the field trip for report during the next lesson. (iii) Teacher should encourage students to sketch and colour landscapes and trees and plants during trips, and to take photographs of various scenes which include natural vegetation and trees and plants specially planted in parks.	(i) Students should prepare notes on field trips for presentation during the next lesson. (ii) Students should mount sketches, paintings and photographs for the next lesson.	Evaluation will be based principally on the next lesson's activities.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to appreciate the recreational and aesthetic value of both natural vegetation and that occurring through human intervention.	(i) Students should read reports on field trips. (ii) Teacher should guide discussion on reports and help students to focus attention on the recreational and aesthetic value of the vegetation they observed. (iii) Students should mount an exhibition of their sketches, paintings and photographs.	Students should research on how vegetation helps in the conservation of our water supply.	Teacher should appraise student reports and exhibition.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to appreciate the recreational and aesthetic value of both natural vegetation and that occurring through human intervention.	(i) Students should read reports on field trips. (ii) Teacher should guide discussion on reports and help students to focus attention on the recreational and aesthetic value of the vegetation they observed. (iii) Students should mount an exhibition of their sketches, paintings and photographs.	Students should research on how vegetation helps in the conservation of our water supply.	Teacher should appraise student reports and exhibition.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to recognize the importance of vegetation to the protection of watersheds, for ensuring good infiltration of water to underground aquifiers, and for avoiding siltation.	(i) Students should report on the finding of their research. (ii) Teacher should use student findings, with the aid of charts and diagrams, to explain the importance of vegetation for the protection of watersheds, for ensuring good infiltration of water to underground aquifiers, and for avoiding siltation.	Students should write one paragraph explaining how vegetation helps in the conservation of our water supply.	Teacher should appraise the paragraph written by students (See Assignment).

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) state at least three ways in which man contributes to the destruction of vegetation. (ii) recognize some of the consequences of destruction of vegetation by man.	(i) Students should state ways in which man contributes to the destruction of vegetation. (ii) Teacher should use student response as the basis for initiating discussion on ways in which man contributes to the destruction of natural vegetation, in particular. (iii) Teacher should guide discussion to focus on (a) logging for timber, (b) shifting cultivation practiced by farmers, (c) fires deliberately started, (d) grazing of seedlings. (iv) Students should state some of the immediate and subsequent consequences of such destruction. (v) Teacher should guide discussion to focus on the destruction of wildlife and soil erosion.	Students should prepare a short newspaper article or a speech pointing to the destruction of vegetation in Barbados, its consequences, and most important of all, proposals for dealing with these consequences and for preventing future occurrence.	Students should write down three important ways in wich man contributes to the destruction of natural vegetation and three consequences of such destruction.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) explain the implications of the destruction of the vegetation. (ii) identify measures already undertaken to conserve vegetation. (iii) identify additional measures which may be taken.	(i) Students should read their newspaper reports, and make their speeches, to the rest of the class (See Assignment, Lesson 8). (ii) Students should engage in a discussion of the points raised in the presentation. (iii) Teacher should list on chalkboard the major consequences raised in the reports, adding to them if necessary. (iv) Teacher should list conservation measures mentioned in the reports which have already been implemented in Barbados and other territories in the Caribbean, adding to the list if necessary. (v) Teacher should list those measures mentioned in reports which have not yet been implemented, adding other possible measures if necessary.	Students should compile list of conservation measures already taken in Barbados and another list of additional measures which may be implemented.	Teacher should check assignment.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to appreciate the need for protecting vegetation in the Graeme Hill Swamp of Barbados.	(i) Student should study the article 'Save the Graeme Hall Swamp.' (ii) Teacher should encourage students to focus on the possible and actual consequences of the destruction of vegetation in the Graeme Hall area. (iii) Teacher should guide a discussion on the possible and actual consequences of destruction of vegetation in the Graeme Hall area.		Evaluation should take place by way of appraisal of student participation and discussion.

UNIT IV (a)

WATER - POLLUTION AND MANAGEMENT

UNIT IV (a) WATER - POLLUTION AND MANAGEMENT

Introductory Statement

Ours is a very wet planet. Approximately three quarters of the earth's surface is water - oceans, seas, rivers, lake, streams, etc. Water is almost everywhere. The human body contains large amounts of it, as does the food we eat. Indeed, water is a life force for all living things in that all forms of animal and plant life are dependent on it. Water is as vital to man as the food he eats and the air he breathes. Not only does he need to drink it regularly to maintain a healthy body, but he also needs it for the plants and animals on which he depends for food.

Even though our planet has such and abundance of water, just a small portion (about three percent) of it is suitable for man's consumption. Added to this, is the fact that there is an uneven distribution of earth's fresh water resources. Vast tracts of land called deserts have very little fresh water available.

In addition to the limited supply of fresh water resource, man has to be careful with this precious natural resource. Water can be a source of danger despite the fact that it is useful and vital to man. It can carry diseases harmful to man. It is easily contaminated through poor disposal of human waste, chemical waste from industrial plants, and toxic substances used against pests in agriculture. There is also the threat of earth's fresh water supply diminishing through drought, and man's indiscriminate use and wastage.

Conservation and preservation of this vital natural support system is therefore of utmost importance. This is even more urgent in the light of

the expanding world population and increased industrial activity, both of which lead to increased demand for fresh water. This precious natural resource must be so managed that a safe and adequate supply is available to all living organisms at all times.

UNIT IV (a) WATER - POLLUTION AND MANAGEMENT

General Objectives

Students should be able to:

(i) appreciate that water is a vital natural resource, important to all living things.

(ii) show an awareness of ways in which water can become polluted.

(iii) appreciate the need for proper management, control and protection of our fresh water resources.

Concepts

(i) Water is natural habitat for animal and plant life.

(ii) Mankind faces a serious shortage of fresh water supply due to pollution by man's domestic and industrial activities and by his indiscriminate use and wastage of that resource.

(iii) Conservation and preservation of earth's fresh water resources are absolutely necessary.

Resources and References

(i) Hassanah, Amena. The Fresh Water Environment, Trinidad Naturalist Vol. 3, No. 8. pp 26-27.

(ii) Senn, Alfred. Geological Investigation of the Ground Water of Barbados, B.W.I. 1946, pp. 12-14.

(iii) Filmstrips

How Barbados Gets Its Water Supply	1268 SS 131
The Story of Underground Waters	G 38 No. 499
Enough Water for Everyone	Ag 53

Correlation

(i) Integrated Science

(ii) Agricultural Science

(iii) Biology

(iv) Social Studies

(v) Geography

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) recognize that water covers almost 75% of earth's surface. (ii) demonstrate an awareness that water is an important natural resource.	(i) Students should examine a globe and/or map of the world to compare the water mass to land mass. (ii) Student should estimate ratio of water to land. (iii) Students should list forms in which earth's water resources are available. (iv) List should be written by teacher on chalkboard. (v) Students' attention should be drawn to the fact that of this abundant supply of water on earth, only about 3% of this is fresh water suitable for man's consumption. (vi) Students are then to select from the list they made those that are sources of fresh water. They should then select fresh water sources found in Barbados.	(i) Students should list in their notebook main land mass and water mass on earth. (ii) Students should group fresh-water sources into surface sources and sub-surface sources.	Teacher should appraise pupils participation in discussion. Check written assignments and note how students organize and present information.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) recognize that water undergoes physical changes. (ii) recognize that many substances dissolve in water.	(i) Elicit from students the source of all fresh water on earth. (ii) Students should design simple activities to show the changes of evaporation and condensation in water. (iii) Involve students in simple activities to show dissolving properties of H_2O, Identify solution, solvent, and solute.	Draw a diagram of water cycle. Get class to set up a sealed terrarium to show the water cycle removal. Predict how vegetation can affect climate.	Assess how well pupils use the concepts of evaporation and condensation to explain the water cycle.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to recognize that all underground water in Barbados comes from rainfall.	(i) Students should list all that happens to rain when it falls to earth, e.g. some evaporates, some is taken up by plants, some runs off to seas and rivers, some percolates through the ground and feeds underground reservoirs. (ii) Read section entitled 'The Process of the formation of the undergr und reservoirs in coral rock area' in Report on Geological Investigation of the Ground Water Resources of Barbados, by A. Senn, pp. 12-13. (iii) 'How Barbados Gets Its Water Supply,' Show film No. 1268 SS131 and 'The Story of Underground Waters' G 38, No. 499.	Students should find out the meaning of the following terms: aquifier, water table, water runoff, watershed, sheet water, spring water, stream water	Teacher should note how pupils organize information from several sources.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to observe that many forms of animal and plant life can be found in surface water.	(i) Students should work in groups of three; each group should carry out two of the following activities at a pond or swamp in the environment: (a) Use pH indicator to measure the level of acidity. (b) Measure temperature of the pond at surface and at measured depths below the surface. Repeat at intervals of one metre across the surface. (c) Take mud sample; use a sieve to wash away mud and list living organisms found. (d) Conduct hardness tests of the water taken at points by adding liquid detergent with a teat pipette (one drop at a time) to a given measured volume of water. Record how much is added before suds form. (e) Take back some of the water to the classroom, and examine it for tiny forms of life. (f) Examine pond and record all plants as well as animals seen in the water. (ii) Relate reading assignment to investigation done at pond or swamp.	Students should (i) write up activities and discuss results. (ii) draw a food web to show how living things found are interdependent. (iii) make diagrams of organisms found (iv) Read A. Hassanaly, "The Fresh Water Environment," Trinidad Naturalist, Vol. 8, pp. 26-27.	(i) Check written assignment for clarity and accuracy of ideas. (ii) Note how students work together and share ideas with each other. Assess students' written assignment for organization and expression of ideas as well as understanding of scientific concepts involved.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) identify the ways in which water is useful. (ii) recognize the need for treatment and disposal of domestic wastewater.	(i) Students should list all uses to which water is put in the home and should relate these uses to physical properties of evaporating and dissolving. (ii) Students should consider what happens to wastewater as well as list those substances that can be found in wastewater. (iii) Teacher should suggest effects of some of these substances if water is not properly treated. (iv) Arrange visit to sewage disposal plant to find out how watewater is treated there.	(i) Students should prepare a discussion on problems that can arise from poor sanitation or get information about water-borne diseases. Find out measures taken by the health authorities against these diseases. Investigate immunization programs of the Ministry of Health. (ii) Student should make oral report on visit to sewage disposal plant.	(i) Teacher should note pupils' participation in discussion. (ii) Check written assignment for arrangement and clarity of ideas.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) recognize that fresh water is used in industry. (ii) recognize that water is also used for relaxation.	(i) Teacher should point out to students that water is used widely in industry as well as in agriculture. (ii) Students should suggest where local power station dumps its wastewater. Students should also list waste of other industries and suggest where these wastes go. (iii) Teacher should point out that water is also used for recreation, and that large expanses of water are very scenic. (iv) Students should name the ways in which water is used for recreation.	Students should: (i) find out which industries in Barbados use large amounts of fresh water. (ii) make a list of different types of water sporting activities.	Assess students' organization of information collected from various sources.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) define a pollutant. (ii) describe the appearance of polluted water.	(i) Students should give their own definitions of the terms in the following activities. (ii) Teacher should then state that anything that changes the chemical content of water in the water supply prevents or limits further use or impairs man's aesthetic enjoyment of water can be called a pollutant. (iii) Teacher should point our that heat is a pollutant. (iv) Teacher should group pollutants into two groups, bio-degradable and non-biodegradable. (v) Teacher should elicit from students ways of identifying polluted water, i.e., by smell, colour (murky), presence of bacteria and algae, and absence of fish.	Students should (i) list pollutants from the use of water for domestic purposes. (ii) list pollutants from use of water for industrial purposes. (iii) list pollutants from use of water for agricultural purposes. (iv) find the meaning of eutrophication and describe how eutrophication takes place.	Teacher should: (i) check accuracy of lists. (ii) assess research findings.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to show an awareness of the need to keep our fresh water supplies free from contamination.	(i) Students should read 'Man and the Ecosystem,' Trinidad Naturalist Vol.3, No. 8, pp. 11-12. (ii) Teacher should guide discussion on the above. (iii) Students should list ways in which individuals pollute fresh water supplies - both ground and surface supplies. (iv) Students should list industrial pollutants of water.	Students should read 'Pollution of Water,' pp. 29-41 of The Spoiled Earth - How and Why Series.	Teacher should: (i) appraise pupils' participation in discussion. (ii) note concern shown for the environment.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) list measures that should be taken to ensure that our water supply is safe and uncontaminated. (ii) appreciate that increased economic activity means increased usage of water.	(i) Students should state what part they can play in helping to maintain a clean water supply. (ii) Teacher should list suggestions on board. (iii) Measures that could be taken by governments, e.g., legislation and building sewage disposal plants, should also be listed. (iv) Students should recap problems encountered with removal of vegetation and increased water runoff, leading to less water percolating down to underground reservoirs. (v) Students should predict what problems increased demand but decreased supply of water can create.	Students should: (i) write an essay on problems faced by Barbados in relation to waste of water and pollution of water supply. (ii) find out what laws exist in Barbados for combatting water pollution.	Teacher should appraise assignments (i) and (ii).

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to show an awareness of the need to conserve water.	(i) Students should list some of the ways in which individuals waste water. (ii) Students should identify some of these ways in the immediate environment and action that could be take to correct. (iii) Students should consider how industry can help reduce wastage and contamination. (iv) Teacher should arrange visit to Banks Breweries Ltd., where recycling of waste water is done. (v) Students should watch film strip "Enough Water for Everyone." (Ag 53) (vi) Teacher should discuss part government plays in ensuring that fresh water resources are conserved.		Teacher should note how well students identify with ways in which water is wasted, i.e., do students admit to wasting water and consider corrective behaviour?

UNIT IV (b)

AIR - POLLUTION AND PREVENTIVE MEASURES

UNIT IV (b) AIR - POLLUTION AND PREVENTIVE MEASURES

Introductory Statement

Air, like water, is another vital life support system of all living organisms. Man's activities, such as large scale removal of natural vegetation, increased use of motor transportation, and increased industrial activity, have all contributed to the overburdening of the air with harmful pollutants. The result of this overburdening is a threat to the health, well-being and survival of all animal and plant life.

UNIT IV (b) AIR - POLLUTION AND PREVENTIVE MEASURES

General Objectives

Students should be able to:

(i) Name various pollutants of the air.

(ii) Identify preventive and corrective measures to deal with air pollution.

Concepts

(i) Air is vital to all living organisms.

(ii) Man's activities in a modernized world are contributing harmful pollutants to the air.

(iii) Corrective and preventive measures need to be taken to deal with problems of air pollution.

Resources and References

(i) Joseph, Anthony. The Influence of Air Pollution on Agricultural Crops. Trinidad Naturalist Vol. 3, No. 8, pp. 34-37.

(ii) Pollution of the Air - The Spoilt Earth. How and Why Series, pp. 14-21.

Correlation

(i) Geography

(ii) Integrated Science

(iii) Chemistry

(iv) Biology

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to state why the percentage composition of CO_2 and O_2 in the air is kept constant.	(i) Teachers should discuss respiration in animals and should illustrate the CO_2 -- O_2 cycle. (ii) Students should suggest ways in which this cycle can be upset on earth. (iii) Students should discuss photosynthesis and respiration. (iv) Teacher should illustrate on chalkboard how these two processes maintain balance of CO_2 and O_2 in atmosphere. (v) Students should suggest ways in which this balance can be upset.	(i) Research the effects of overcrowding on the earth's atmosphere. (ii) Research the effects which the removal of natural vegetation have on the air. (iii) Research the effect which extensive burning of fossil fuel would have on the atmosphere.	Appraise written assignments (i) (ii) and (iii) for accuracy and proper organization.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to show an awareness of the fact that pollutants in the air affect man's health.	(i) List different kinds of pollution in the community. (ii) Select air pollution and write down specific substances causing the pollution. (iii) Students should state what methods exist for combating air pollution and what local laws exist on pollution. (iv) Students should read article on pollution of air in Spoilt Earth - How and Why Series. (v) Teacher should guide discussion on article.	(i) Students should write essay on the common air pollution problems in the community. They should suggest preventive and corrective measures to deal with the problems. (ii) Students should collect information on dangers of increased CO_2 in the atmosphere, greenhouse effect, and effect on increased use of sprays on the ozone layer.	Teacher should (i) check assignments. (ii) note student participation in discussion.

UNIT IV (c)

THE MARINE ECOSYSTEM - DESTRUCTION AND PRESERVATION

UNIT IV (c) THE MARINE ECOSYSTEM - DESTRUCTION AND PRESERVATION

Introductory Statement

Most of the earth's surface is covered by oceans and seas. These vast expanses of water are not only important natural resources to mankind but are also a natural habitat for a wide range of animals and plants. The marine environment is used by man for such things as recreation, food source, transport medium, and mineral source, as well as for dumping man's waste material.

Like the other natural habitats of the environment, the seas and oceans are overburdened with man's waste materials, resulting in a threat to the animal and plant life there.

The preservation and conservation of the marine environment therefore need to be emphasized.

UNIT IV (c) THE MARINE ECOSYSTEM - DESTRUCTION AND PRESERVATION

General Objectives

Students should be able to:

(i) demonstrate an understanding that the sea is an important natural resource as well as an ecosystem, and as such should be preserved and conserved.

(ii) show an awareness of the ways in which the marine environment can become polluted.

Concepts

(i) Most of the earth's surface water is in the form of seas and oceans.

(ii) The seas and oceans are used by men in a number of ways.

(iii) The seas and oceans are a natural habitat for many life forms.

(iv) Man's increasing numbers and increasing industrial activities are upsetting the natural balance between the living and non-living components in the sea.

Resources and References

(i) Globe

Correlations

(i) Chemistry

(ii) Biology

(iii) Integrated Science

(iv) Geography

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to recognize that most of the earth's surface is sea or ocean.	(i) Students should examine a globe or map of the world to locate and name the main bodies of water. (ii) Students should refer to a map of West Indies and locate the Caribbean Sea and Atlantic Ocean. They are also to note that Barbados is bounded by the Atlantic Ocean. (iii) Students who have visited those coasts bound by the Caribbean Sea and by the Atlantic Ocean should describe wave activity, beach rock appearance, and rock formation.	Students should: (i) make a list of main oceans and seas. (ii) make a written summary of discussion.	Teacher should: (i) appraise students' willingness to share ideas and experiences (ii) check written assignments for accuracy and organization of points made during lesson.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to recognize that the sea is a natural habitat for a wide range of animal and plant life.	(i) Visit beach, collect samples of animal and plant life. (ii) Collect some sea water, examine under microscope for microscopic organisms. Look for plankton, diatoms, algae. (iii) Check under rocks for living organisms.	Make up a food chain, using organisms found on the beach and in the sea water. Identify producers, consumers.	Note how students relate observations to basic scientific concepts of inter-relationships between and among living organisms.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to realize that the sea provides man with a cheap source of proteins.	(i) Get students to list foods acquired from the sea. (ii) Compare the cost of obtaining such foods with the cost of rearing poultry or other livestock. (iii) Arrange for a visit to wharf or Oistins Fish Market to see activity in a fishing area. Identify types of fish brought in. (iv) Refer students to the problem of diminishing supplies of sea urchins, experienced now in Barbados. Students are to give reasons for this situation and then discuss the possibility of this problem arising with fish. (v) Students should suggest measures needed to ensure that fish supply is not exhausted.	Students should: (i) interview a fisherman to find out about his fish catching methods. (ii) Write summary of discussion on activity (iv) and (v).	Teacher should: (i) note participation of students in discussion. (ii) Appraise pupils participation in discussion and how well they can relate problems of disappearing life forms to changes in the environment.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) appreciate the use of the sea as a major means of transport. (ii) list the problems associated with the use of the sea by seagoing vessels.	(i) Students should be given the types of vessels which use the sea, e.g., oil tankers, cargo ships and cruise ships. (ii) Teacher should arrange for visit to Needle's Point and other areas where ocean-going vessels may be observed. (iii) Students should list problems associated with the frequent use of sea by ocean-going vessels. (iv) Students should predict effect of (a) oil slicks on surface of water on fish and other life forms such as sea birds and (b) dumping of ship's waste in the sea.	Students should write two paragraphs on 'Problems of Pollution Caused by Sea-Going Vessels.'	Assess written assignment for clarity, organization of ideas, and concern for the care of the sea.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) recognize that the sea is a source of valuable minerals. (ii) show an awareness of international conflicts concerning the sea.	(i) Students should be given examples of minerals acquired from the sea, e.g., crude oil, natural gas, and sodium chloride, and asked to add to list. (ii) They should be asked to suggest ways in which drilling crude oil in ocean floor can affect marine environment. (iii) Students should participate in discussion on the question of extension of limits of territorial waters by some nations. Teacher should guide discussion so that it helps to clarify the meaning of international waters and the objectives of the Law of the Sea Conference.	Students should collect information about manganese nodule and the controversy surrounding the mining of these minerals found on the sea floor. Students should write summary of discussion on activity (iii).	Appraise students awareness of problems by questions asked and kind of information generated.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) show an awareness of the sea as a source of energy. (ii) appreciate that the sea may be a source of pleasure as well as of scientific investigation.	(i) Students should indicate how waves could be used as a source of energy. (ii) Teacher should guide discussion on the feasibility of wave energy in Barbados. The cost, technology and maintenance should be examined. (iii) Students should identify water sports in which they have participated. (iv) Students should tell of kinds of studies carried out in and on the sea. (v) Students are also to name their sources of information.	Students should: (i) research tidal and wave energy. (ii) find out countries which use these alternative sources of energy. (iii) research on the type of marine investigations conducted in Barbados.	Assess assignments (i), (ii) and (iii). Note pupils' participation in discussion.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) recognize that the sea is used for dumping man's waste. (ii) show an awareness of the fact that increased coastal activity can also affect living organisms in the sea.	(i) Students should discuss effects of sewage dumped in sea from sea-going vessels on cities and towns and on marine organisms. (ii) Students should discuss as well the effects of dumping of radio-active waste on sea-bed. (iii) Student should predict the effects of increased building on sea coast, e.g., effects of dumping of building material, destruction of coral reefs, land reclamation, blasting. (iv) Or get a member of 'Window to Sea' group to speak on the issue.	Students should do essay on the following: 'Should there be laws concerning the dumping of materials in sea?' If so who should enforce such laws? Collect newspaper reports about problems to the marine environment of coastal activity. Find out if there are laws relating to building on beaches.	Assess written assignment for presentation of ideas and arguments advanced. Appraise pupils' ideas and observations for expression of concern for the proper management of the marine environment.

UNIT V (a)

NATURAL DISASTERS AND THEIR EFFECTS ON THE ENVIRONMENT

UNIT V (a) NATURAL DISASTERS AND THEIR EFFECTS ON THE ENVIRONMENT

Introductory Statement

Not only have man's activities altered the natural environment on earth, but forces of nature cause massive and widespread disruptions of the natural environment.

Caribbean countries face in a very real way the yearly threat of hurricanes. They face as well the threat of volcanoes which can erupt at any time and with very little warning.

Unit V (a) NATURAL DISASTERS AND THEIR EFFECTS ON THE ENVIRONMENT

General Objectives

Students should be able to:

(i) show an awareness of the ways in which the total environment is disrupted by hurricanes and volcanoes.

(ii) show an appreciation for the importance of disaster preparedness.

Concept

(i) Hurricanes and volcanoes have disastrous effects on a country.

(ii) Man must use his knowledge of conservation and careful management of the environment to help restore the disrupted environment.

Resources and References

(i) Hurricane David. Bajan, Oct. 1979. 311, pp. 4-9.

(ii) Barnard, M. and Richardson, D. The Eruption of La Soufriere. Bajan, May, 1979, 306, pp. 24-27.

Correlation

(i) Geography

(ii) Social Studies

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) describe briefly how hurricanes occur. (ii) state the effects of hurricanes on people.	(i) Encourage students to relate their own experience (if any) of hurricanes, or stories they have heard about hurricanes. (ii) Ask students to explain how winds can become so powerful. (iii) Listing by students of immediate dangers and problems people face during a hurricane.	Students should use encyclopaedia or any other resource material to get information describing hurricanes.	Teacher should appraise pupils' participation in discussion. Assess assignment for clarity and orderly presentation of information.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) appreciate the need for disaster preparedness. (ii) state the outcome of destruction of vegetation by hurricanes.	(i) Get pupils to state the kinds of action that can be taken before and during a hurricane to cope with these dangers. (ii) Remind students of effects of removal of vegetation by man. (iii) List effects of hurricanes on chalkboard. (iv) Students should group these effects into those that are immediate and those that are longterm.	(i) Students should find out what 'Disaster Preparedness' plans are made in Barbados. (ii) Students should summarize major points which emerge from lesson.	Assess assignments (i) and (ii).

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to state the problems faced when fresh water supplies are disrupted and contaminated.	(i) Point out to students that another serious problem faced after a hurricane is possible loss of a fresh water supply. (ii) Encourage students to list ways in which the fresh water supply can be disrupted. (iii) Encourage students to predict disruptions and to state precautionary measures that can be taken before and after a hurricane.	Students should collect clippings from newspapers or magazines on hurricanes and start a scrap book on hurricanes.	Teacher should check clippings for relevance.

UNIT V (b)

LOOKING AHEAD

UNIT V (b) LOOKING AHEAD

Introductory Statement

Over the past decades a number of national and international organizations have been formed and have provided the opportunity for trained personnel to cooperate in taking action designed to provide for more sensible use of the earth and its resources.

Without doubt the preservation of our environment is receiving increasing attention. It is generally accepted that unless mankind can find urgent solutions to his global environmental problems, the quality of life will be greatly diminished.

Everyone should, therefore, be concerned with, and be involved in, preserving the earth and its resources, in ensuring the protection of wildlife, in pursuing various types of conservation projects, and in preventing pollution. Yet many people underestimate the magnitude of the environmental problem around us. One would concede that governments must be supported in such an undertaking by private citizens. As one writer puts it, the preservation of our environment is "a challenge which the world has to tackle now, and in the end it is the basic attitude on every farm and in every factory, street and garden that will decide our future."

General Objectives

Students should be able to:

(i) appreciate the need for cooperative action to preserve the earth and its resources.

(ii) recognize the role they can play in preserving the earth and its resources.

Concepts

(i) National and international organizations facilitate work aimed at preserving the earth and its resources.

(ii) Unless mankind can find urgent solutions to some major global environmental problems the quality of the environment will be diminished.

(iii) Everyone has a role to play in preserving the earth and its resources.

Resources and References

(i) Jackson, O.J. Conservation and Pollution. London: B.T. Batsford, 1971, pp. 83-93.

Correlation

(i) Geography

(ii) Social Studies

(iii) Integrated Science

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to state ways in which national organizations, regional organizations, and international organizations co-operate in implementing measures aimed at helping to preserve the earth and its resources.	(i) Students should list national, regional and international organizations involved in the work of environmental conservation. (ii) Teacher should guide a discussion on the role of each organization or each set of organizations in helping to preserve the earth and its resources. (iii) Teacher should stress value of co-operative actions among national, regional and international organizations. (iv) Students should be encouraged to explore more fully the role of a few of the organizations mentioned in facilitating co-operation in preserving the earth and its resources.	Each student should investigate the role of at least one national, regional or international organization in facilitating work aimed at preserving the earth and its resources.	

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) recognize the need for individuals to be actively involved in helping to preserve the earth and its resources. (ii) appreciate the need to avoid actions inimical to the preservation of a proper environment.	(i) Students should state some of the human behaviours and actions which are inimical to the preservation of the earth and its resources or to the proper management of the environment. (ii) Teacher should guide discussion about each behaviour or action mentioned, stressing the need to avoid such actions. (iii) Students should then state specific ways in which they, as individuals, may contribute to the preservation of the earth and its resources, and to the proper management of the environment.	Students should research on some of the major global environmental problems facing mankind.	Teacher should evaluate student contribution to discussion.

SPECIFIC OBJECTIVE	LEARNING ACTIVITY	ASSIGNMENT	EVALUATION
Students should be able to: (i) recognize the magnitude of the global environmental problem. (ii) appreciate the need for careful monitoring of environmental problems and proper management of the environment.	(i) Students should report their findings on major environmental problems (see Assignment, Lesson 2.) (ii) Teacher should encourage discussion of each major problem, pointing to the actual and potential disastrous consequences which may accrue and to the need for remedial action. (iii) Teacher should stress the need for the involvement of all in combating the environmental problems and in preserving the earth, its resources and mankind.	Students should list major global environmental problems.	Teacher should evaluate students' contributions based on their research and their classroom discussion.

APPENDICES

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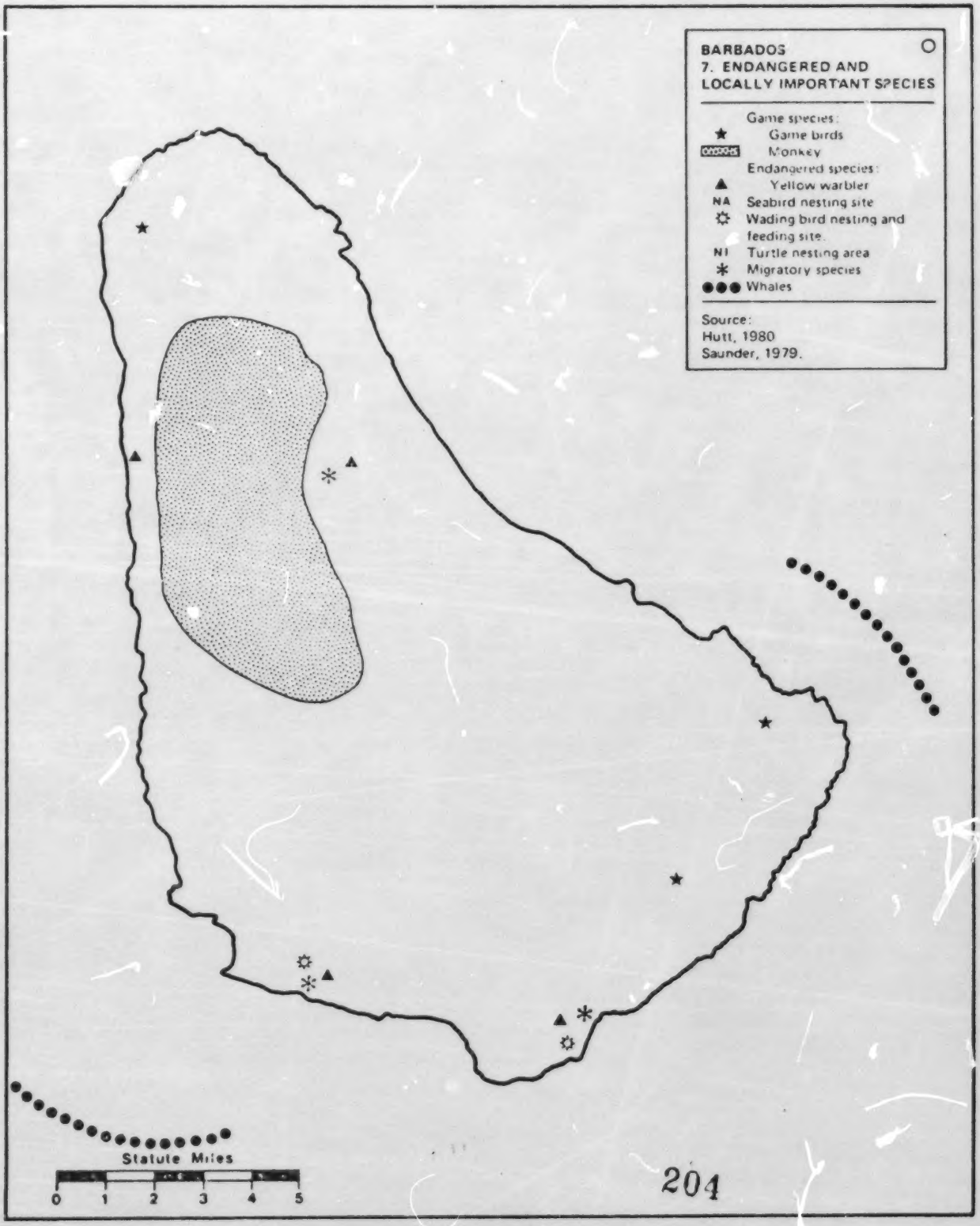
RESOURCE DATA MAPS • BARBADOS



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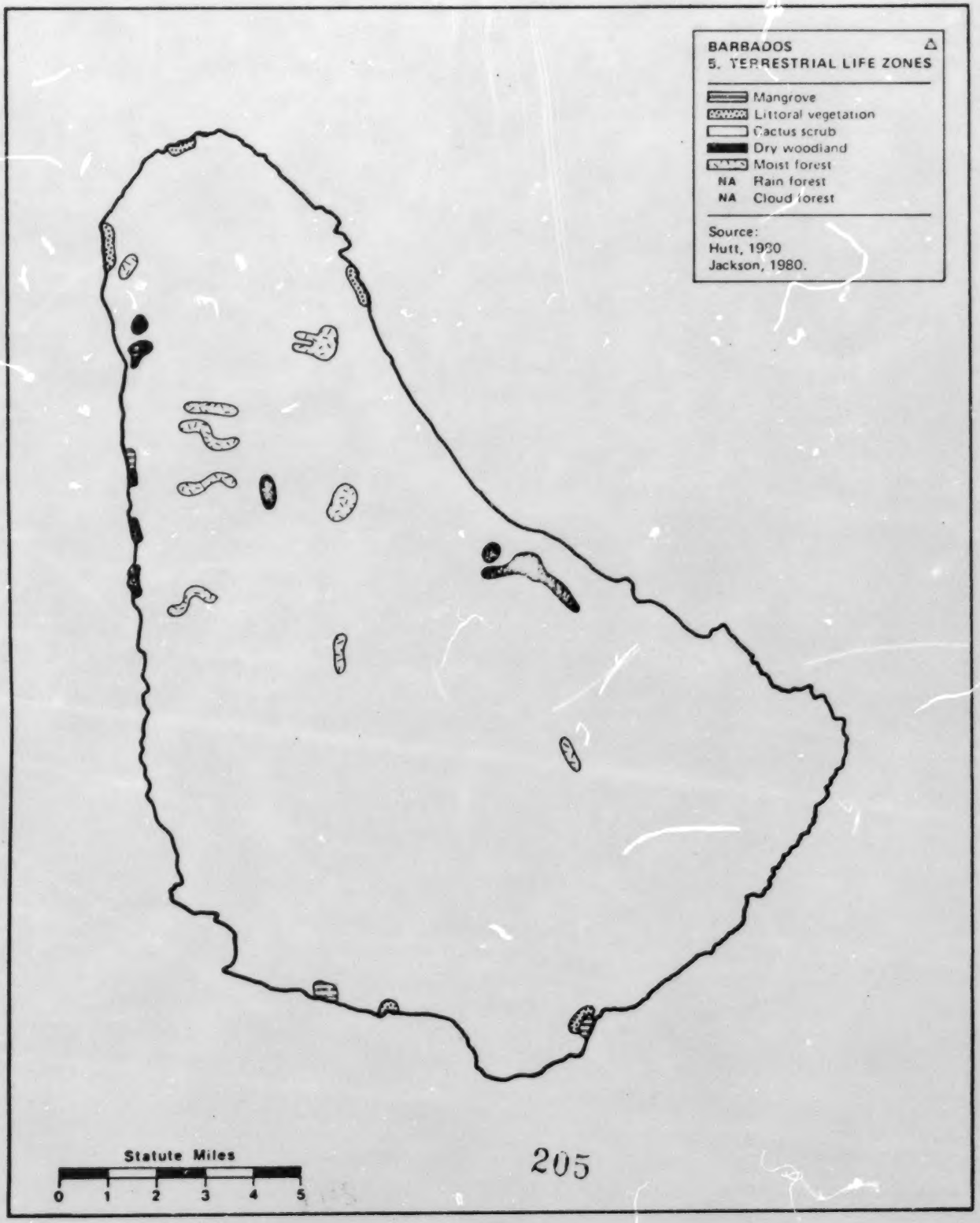

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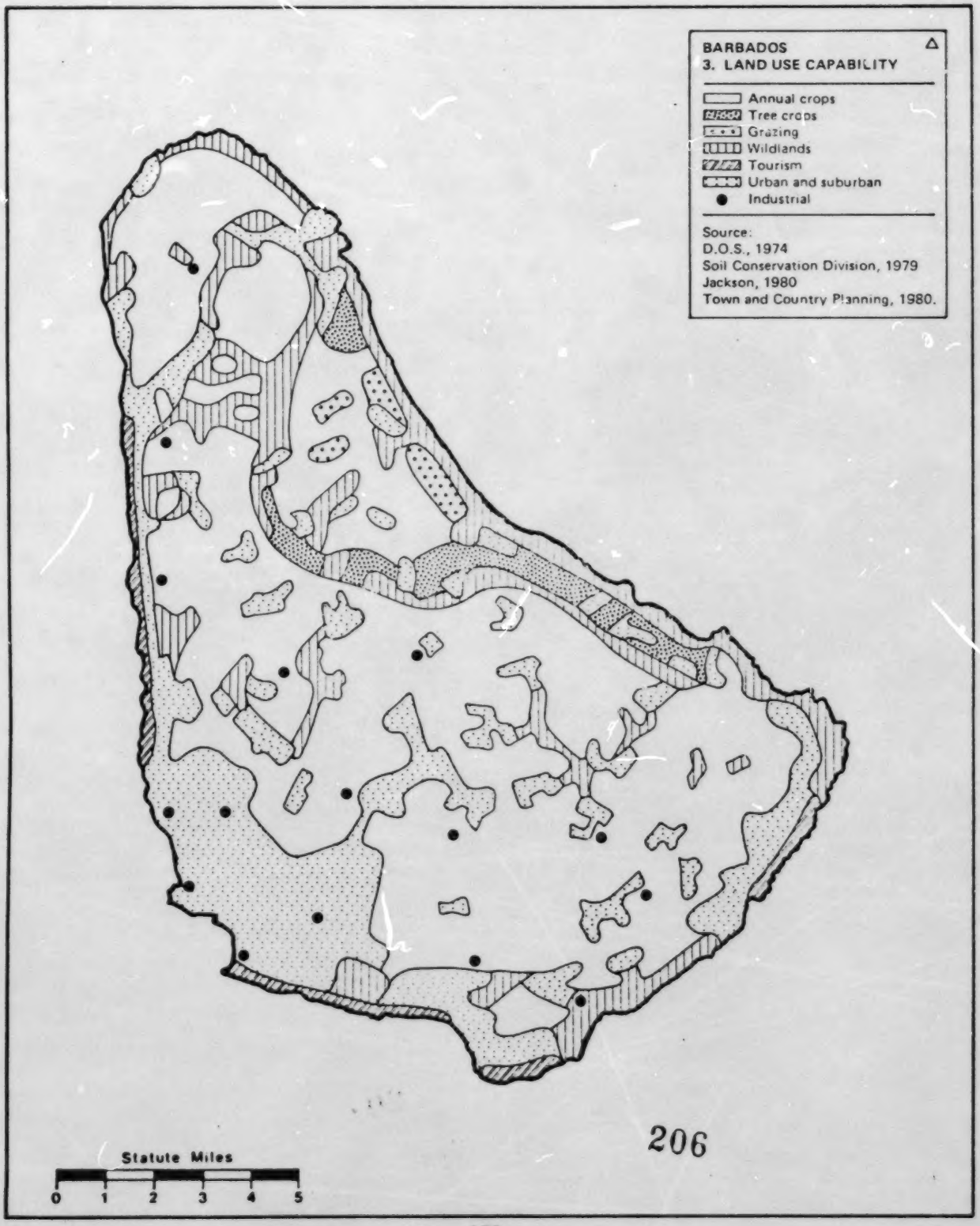

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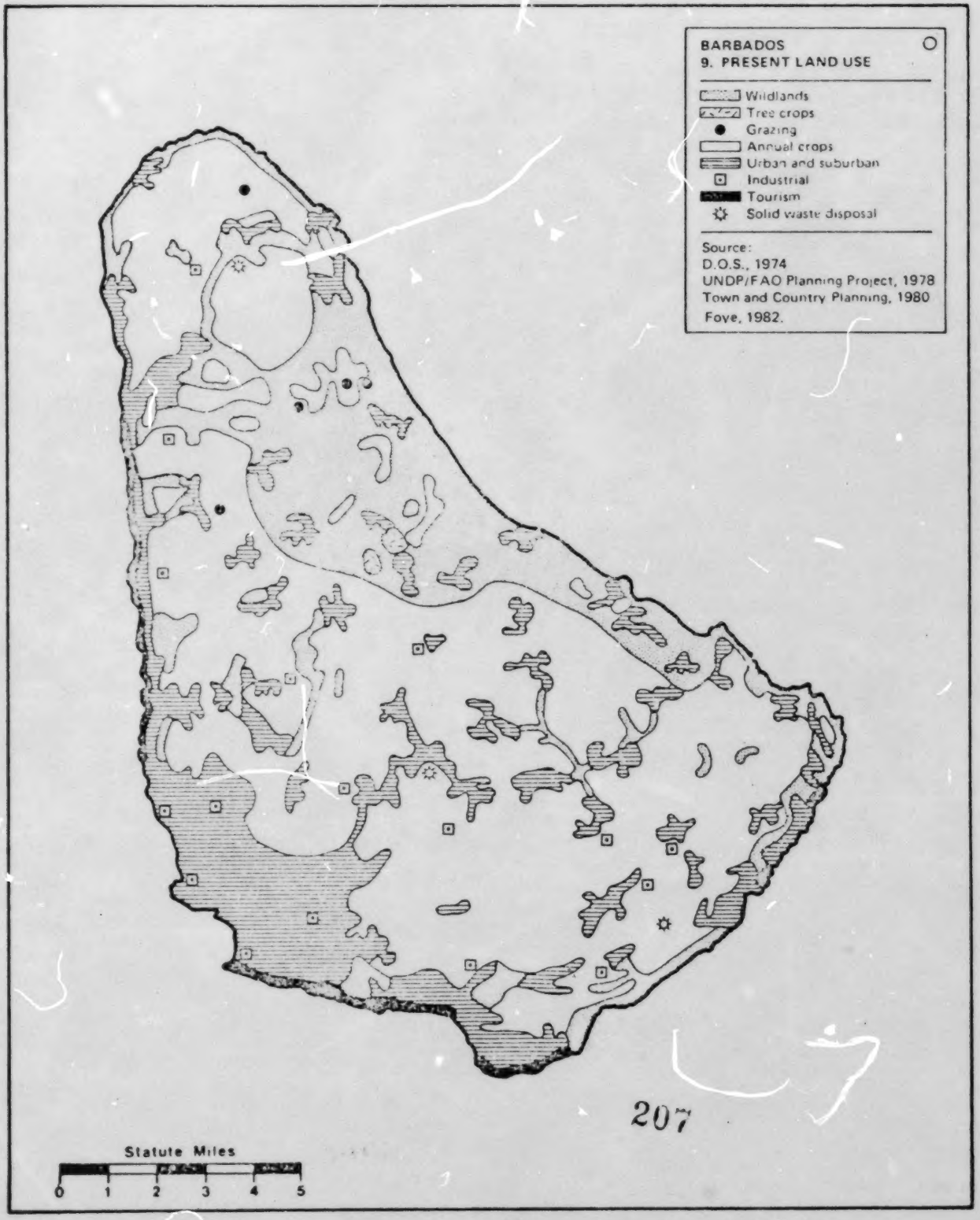

Appendix E

LAND CAPABILITY CLASSIFICATION*

LAND SUITED TO CULTIVATION AND OTHER USES

Class I--Soils in class I have few limitations that restrict their use.

Soils in this class are suited to a wide range of plants and may be used safely for cultivated crops, pasture, range, woodland, and wildlife. The soils are nearly level[1] and erosion hazard (wind or water) is low. They are deep, generally well drained, and easily worked. They hold water well and are either fairly well supplied with plant nutrients or highly responsive to inputs of fertilizer.

The soils in class I are not subject to damaging overflow. They are productive and suited to intensive cropping. The local climate must be favorable for growing many of the common field crops.

In irrigated areas, soils may be placed in class I if the limitation of the arid climate has been removed by relatively permanent irrigation works. Such irrigated soils (or soils potentially useful under irrigation) are nearly level, have deep rooting zones, have favorable permeability and water-holding capacity, and are easily maintained in good tilth. Some of the soils may require initial conditioning including leveling to the seasonal water table. Where limitations due to salts, water table, overflow, or erosion are likely to recur, the soils are regarded as subject to permanent natural limitations and are not included in class I.

Soils that are wet and have slowly permeable subsoils are not placed in class I. Some kinds of soil in class I may be drained as an improvement measure for increased production and ease of operation.

Soils in class I that are used for crops need ordinary management practices to maintain productivity--both soil fertility and soil structure. Such practices may include the use of one or more of the following: Fertilizers and lime, cover and green-manure crops, conservation of crop residues and animal manures, and sequences of adapted crops.

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[1]Some rapidly permeable soils in class I may have gentle slopes.

*From A. A. Klingebiel and P. H. Montgomery, Land-Capability Classification. U. S. Department of Agriculture, Soil Conservation Service, Agriculture Handbook No. 210, 1976, pp. 6-10.

Class II--Soils in class II have some limitations that reduce the choice of plants or require moderate conservation practices.

Soils in class II require careful soil management, including conservation practices, to prevent deterioration or to improve air and water relations when the soils are cultivated. The limitations are few and the practices are easy to apply. The soils may be used for cultivated crops, pasture, range, woodland, or wildlife food and cover.

Limitations of soils in class II may include singly or in combination the effects of (1) gentle slopes, (2) moderate susceptibility to wind or water erosion or moderate adverse effects of past erosion, (3) less than ideal soil depth, (4) somewhat unfavorable soil structure and workability, (5) slight to moderate salinity or sodium easily corrected but likely to recur, (6) occasional damaging overflow, (7) wetness correctable by drainage but existing permanently as a moderate limitation, and (8) slight climatic limitations on soil use and management.

The soils in this class provide the farm operator less latitude in the choice of either crops or management practices than soils in class I. They may also require special soil-conserving cropping systems, soil conservation practices, water-control devices, or tilage methods when used for cultivated crops. For example, deep soils of this class with gentle slopes subject to moderate erosion when cultivated may need one of the following practices or some combination of two or more: Terracing, stripcropping, contour tillage, crop rotations that include grasses and legumes, vegetated water-disposal areas, cover or green-manure crops, stubble mulching, fertilizers, manure, and lime. The exact combinations of practices vary from place to place, depending on the characteristics of the soil, the local climate, and the farming system.

Class III--Soils in class III have severe limitations that reduce the choice of plants or require special conservation practices, or both.

Soils in class III have more restrictions than those in class II and when used for cultivated crops the conservation practices are usually more difficult to apply and to maintain. They may be used for cultivated crops, pasture, woodland, range, or wildlife food and cover.

Limitations of soils in class III restrict the amount of clean cultivation; timing of planting, tillage, and harvesting; choice of crops; or some combination of these limitations. The limitations may result from the effects of one or more of the following: (1) Moderately steep slopes; (2) high susceptibility to water or wind erosion or severe adverse effects of past erosion; (3) frequent overflow accompanied by some crop damage; (4) very slow permeability of the subsoil; (5) wetness or some continuing waterlogging after drainage; (6) shallow depths to bedrock, hardpan, fragipan, or claypan that limit the rooting zone and the water storage; (7) low moisture-holding capacity; (8) low fertility not easily corrected; (9) moderate salinity or sodium; or (10) moderate climatic limitations.

When cultivated, many of the wet, slowly permeable but nearly level soils in class III require drainage and a cropping system that maintains or improves the structure and tilth of the soil. To prevent puddling and to improve permeability it is commonly necessary to supply organic material o such soils and to avoid working them when they are wet. In some irrigated areas, part of the soils in class III have limited use because of high water table, slow permeability, and the hazard of salt or sodic accumulation. Each distinctive kind of soil in class III has one or more alternative combinations of use and practices required for safe use, but the number of practical alternatives for average farmers is less than that for soils in class II.

Class IV--Soils in class IV have very severe limitations that restrict the choice of plants, require very careful management of both.

The restrictions in use for soils in class IV are greater than those in class III and the choice of plants is more limited. When these soils are cultivated, more careful management is required and conservation practices are more difficult to apply and maintain. Soils in class IV may be used for crops, pasture, woodland, range, or wildlife food and cover.

Soils in class IV may be well suited to only two or three of the common crops or the harvest produced may be low in relation to inputs over a long period of time. Use for cultivated crops is limited as a result of the effects of one or more permanent features such as (1) steep slopes, (2) severe susceptibility to water or wind erosion, (3) severe effects of past erosion, (4) shallow soils, (5) low moisture-holding capacity, (6) frequent overflows accompanied by severe crop damage, (7) excessive wetness with continuing hazard of waterlogging after drainage, (8) severe salinity or sodium, or (9) moderately adverse climate.

Many sloping soils in class IV in humid areas are suited to occasional but not regular cultivation. Some of the poorly drained, nearly level soils placed in class IV are not subject to erosion but are poorly suited to intertilled crops because of the time required for the soil to dry out in the spring and because of low productivity for cultivated crops. Some soils in class IV are well suited to one or more of the special crops, such as fruits and ornamental trees and shrubs, but this suitability itself is not sufficient to place a soil in class IV.

In subhumid and semiarid areas, soils in class IV may produce good yields of adapted cultivated crops during years of above average rainfall; low yields during years of average rainfall; and failures during years of below average rainfall. During the low rainfall years the soil must be protected even though there can be little or no expectancy of a marketable crop. Special treatments and practices to prevent soil blowing, conserve moisture, and maintain soil productivity are required. Sometimes crops must be planted or emergency tillage used for the primary purpose of maintaining the soil during years of low rainfall. These treatments must be applied more frequently or more intensively than on soils in class III.

LAND LIMITED IN USE--GENERALLY NOT SUITED TO CULTIVATION*

Class V--Soils in class V have little or no erosion hazard but have other limitations impractical to remove that limit their use largely to pasture, range, woodland, or wildlife food and cover.

Soils in class V have limitations that restrict the kind of plants that can be grown and that prevent normal tillage of cultivated crops. They are nearly level but some are wet, are frequently overflowed by streams are stony, have climatic limitations, or have some combination of these limitations. Examples of class V are (1) soils of the bottom lands subject to frequent overflow that prevents the normal production of cultivated crops, (2) nearly level soils with a growing season that prevents the normal production of cultivated crops, (3) level or nearly level stony or rocky soils, and (4) ponded areas where drainage for cultivated crops is not feasible but where soils are suitable for grasses or trees. Because of these limitations cultivation of the common crops is not feasible but pastures can be improved and benefits from proper management can be expected.

Class VI--Soils in class VI have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

Physical conditions of soils placed in class VI are such that it is practical to apply range or pasture improvements, if needed, such as seeding, liming, fertilizing, and water control with contour furrows, drainage ditches, diversions, or water spreaders. Soils in class VI have continuing limitations that cannot be corrected, such as (1) steep slope, (2) severe erosion hazard, (3) effects of past erosion, (4) stoniness, (5) shallow rooting zone, (6) excessive wetness or overflow, (7) low moisture capacity, (8) salinity or sodium, or (9) severe climate. Because of one or more of these limitations these soils are not generally suited to cultivated crops. But they may be used for pasture, range, woodland, or wildlife cover or for some combination of these.

Some soils in class VI can be safely used for the common crops provided unusually intensive management is used. Some of the soils in this class are also adapted to special crops such as sodded orchards, blueberries, or the like, requiring soil conditions unlike those demanded by the common crops. Depending upon soil features and local climate the soils may be well or poorly suited to woodlands.

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*Certain soils grouped into classes V, VI, VII, and VIII may be made fit for use for crops with major earthmoving or other costly reclamation.

Class VII--Soils in class VII have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife.

Physical conditions of soils in class VII are such that it is impractical to apply such pasture or range improvements as seeding, liming, fertilizing, and water control with contour furrows, ditches, diversions, or water spreaders. Soil restrictions are more severe than those in class VI because of one or more continuing limitations that cannot be corrected, such as (1) very steep slopes, (2) erosion, (3) shallow soil, (4) stones, (5) wet soil, (6) salts or sodium, (7) unfavorable climate, or (8) other limitations that make them unsuited to common cultivated crops. They can be used safely for grazing or woodland or wildlife food and cover or for some combination of these under proper management.

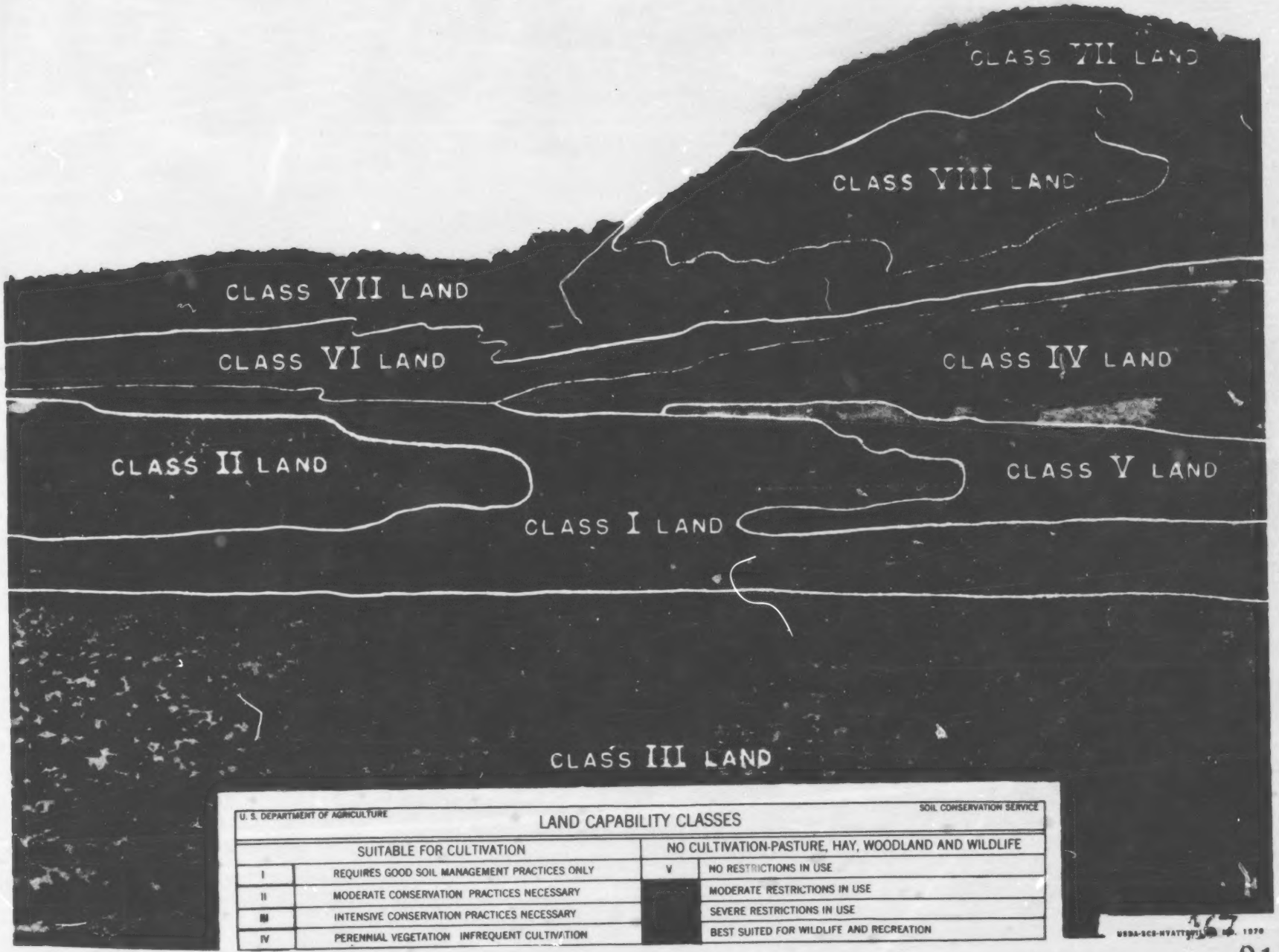
Depending upon the soil characteristics and local climate, soils in this class may be well or poorly suited to woodland. They are not suited to any of the common cultivated crops; in unusual instances, some soils in this class may be used for special crops under unusual management practices. Some areas of class VII may need seeding or planting to protect the soil and to prevent damage to adjoining areas.

Class VIII--Soils and landforms in Class VIII have limitations which preclude their use for commercial plant production and restrict their use to recreation, wildlife, or water supply or to esthetic purposes.

Soils and landforms in class VIII cannot be expected to return significant on-site benefits from management for crops, grasses, or trees, although benefits from wildlife use, watershed protection, or recreation may be possible.

Limitations that cannot be corrected may result from the effects of one or more of the following: (1) Erosion or erosion hazard, (2) severe climate, (3) wet soil, (4) stones, (5) low moisture capacity, and (6) salinity or sodium.

Badlands, rock outcrop, sandy beaches, river wash, mine tailings, and other nearly barren lands are included in class VIII. It may be necessary to give protection and management for plant growth to soils and landforms in class VIII in order to protect other more valuable soils, to control water, or for wildlife or esthetic reasons.


CLASS VII LAND
CLASS VIII LAND
CLASS VII LAND
CLASS VI LAND
CLASS IV LAND
CLASS II LAND
CLASS V LAND
CLASS I LAND
CLASS III LAND
U. S. DEPARTMENT OF AGRICULTURE
LAND CAPABILITY CLASSES
SOIL CONSERVATION SERVICE
SUITABLE FOR CULTIVATION
I REQUIRES GOOD SOIL MANAGEMENT PRACTICES ONLY
II MODERATE CONSERVATION PRACTICES NECESSARY
III INTENSIVE CONSERVATION PRACTICES NECESSARY
IV PERENNIAL VEGETATION INFREQUENT CULTIVATION
NO CULTIVATION-PASTURE, HAY, WOODLAND AND WILDLIFE
V NO RESTRICTIONS IN USE
MODERATE RESTRICTIONS IN USE
SEVERE RESTRICTIONS IN USE
BEST SUITED FOR WILDLIFE AND RECREATION

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APPENDIX F - A LAND USE DECISION-MAKING SITUATION

PURPOSE: To help the students understand the problems involved in making decisions concerning wise use of land.

LEVEL:

SUBJECT: Science
Social Studies

CONCEPT: Natural resources are unequally distributed with respect to land areas and political boundaries thus, conflicts emerge between private land use rights and the maintenance of environmental quality for the general public.

REFERENCE: Larry Steider, General Science Teacher, Highland Jr. High, Sparta, Ohio.[1]

ACTIVITY: There is little disagreement about the fact that our population is increasing and will continue to do so. Accompanying this increase in population will be the increased need for goods and services. There are times when decisions have to be made concerning how our resources are to be used to provide these goods and services.

The following role-playing situation will help students make decisions as to the wise use of land. Mr. Jones is a farmer who owns a farm of 500 acres at the outskirts of a rapidly expanding city of 100,000 people. Half of his farm is covered with forest, the rest is very productive agriculturally. Mr. Jones enjoys his work as a farmer very much. Recently, Mr. Jones has been receiving much pressure from many sides to sell his farm.

Mr. Allen, a local contractor, would like to buy the property to build a housing development that would provide housing for a rapidly rising population. Mr. Bates, the mayor, feels the site would be perfect for a much-needed sewage treatment plant because of the location next to a river and its proximity to the growing part of the community. A group of businessmen, headed by Mr. Smith, feel that this area, which is easily accessible to a main highway, would be a perfect place for a shopping center. A civic action group led by Ms. Fields would like to see the county or city buy the farm and utilize the forest and water resources as a camping and recreation area. The president of the state univeristy is very much interested in procuring the site for a branch campus.

Due to the fact that his farm is taxed on market value, which is very high, and the fact that prices for farm products are so low, Mr. Jones is forced to sell his farm. He has set his price and is aware of all the prospective buyers. Mr. Jones, being civic-minded, wants to make a decision which will most

[1] From Bowman, M.L. and Disinger, J. F. Land Use Management Activities for the Classroom. Columbus, Ohio, ERIC/SMEAC, 1977, pp. 101-102.

benefit his community both now and in the future. He and his lawyer call a meeting of all the groups that are interested in purchasing the farm.

As a class, set up this meeting and act out the various roles. Select a person to represent the mayor, the building contractor, the businessman, Ms. Fields, the university president, and Mr. Jones' lawyer. (Note: There may be other roles you would like to include.)

Have the lawyer conduct a meeting with all the above. He must allow time for each participant to state his case as to why he thinks the farm should be sold to him. The remainder of the class will represent Mr. Jones. They can be permitted to ask questions after each participant has stated his case. When the discussion has ended, have each student decide privately who he thinks the land should be sold to.

You may later want to divide the class into groups of 4 or 5 and discuss their decisions. Have them come to a consensus of opinion.

This case may be highly simplified and not represent the way these types of decisions are usually made but it does help students make decisions about land use management.

APPENDIX G

Wire and Crushed Limestone Rock Keep This Hill Together

By Wynslo Phillips

THE NATION, August 20, 1980

The scenic beauty that is the eastern side of Barbados is quite often taken for granted by visitors and locals, and the wire enclosed gabions of crushed limestone rock embedded in hill sides and adjoining roadsides are often referrred to as "unsightly."

However, the engineering effort, stretched over a 23-year period, by personnel from Government's Soil Conservation Unit, to install those gabions and other soil stabilising devices, is solely responsible for the retention and enhancement of this entire stretch of landscape, ranging from Pico Teneriffe on the border of St. Lucy in the north of Consett Bay in St. John, down to the south.

The area, known as the Scotland District, contains the most elevated part of Barbados and rainfall in the area averages an annual 70 inches, much higher than the rest of the island.

It is also the part of Barbados which has lost its protective coral limestone cap, a victim of the slash and burn system of agriculture practised by the Arawaks and other peoples of an earlier day, exposing the underlying clay-type soils.

The entire area, covering about one-seventh of Barbados, is prone to landslides, slumps and mudflows.

In past years, the considerable amount of topsoil lost by erosion after heavy rainfall produced enormous brown stains in the coastal seawater, especially off the Belleplaine and Cattlewash areas, and planted

fields and housing frequently slipped away downhill.

Over the years, soil conservation engineers and workers have built scores of silt traps, gabions, miles of terraces, and other erosion control mechanisms so that farmers and households can live safely and produce crops with a minimum of damage because of the soil instability.

These efforts have had a great degree of success and now attention is being turned to more indirect soil stabilising efforts.

With recommendations from a study conducted by the Inter-American Development Bank and the Barbados Government, timber soil-stabilising, and fruit trees have been and are still being introduced into certain selected areas and a variety of other agricultural crops will be planted.

Khus-khus and pangola grasses are also being extensively planted throughout the area, and secondary roads are being improved or constructed, along with the building of dams, drains, and terraces.

Two months ago, most of the hillside at Bawdens in St. Andrew experienced a severe landslip, in which some houses were damaged.

Steps were immediately taken to remedy the situation, the first being the removal of all houses on the hillside to other tenantry lands in the area.

The area, some 15 acres, has been reformed and terraced and trees such as citrus, mangoes, cashew, guavas, Honduras Mahogany, gliricidia, and Barbados olives have been planted. Banana plants and khus-khus grass are also there and, as an effort to enable the plants and trees to establish themselves, the entire hillside has been covered with bagasse.

Gabions have also been placed to provide mechanical support for the soil, and similar areas are now being worked on at East River and Greenland.

There are three areas in Scotland district which contain comments of natural forest, Turners' Hall, Morgan Lewis, and Joe's River. The last named, some 90 acres which was purchased by Government in 1964, has been declared a prohibited area to prevent locals cutting down its trees for boat-building, fire wood, and fence and house supports.

In all three areas, especially Joe's River, the forest has been enhanced by planting of mahogany, teak, cedar, eucalyptus, casuarinas, pine, and ipil-ipil.

These trees are also being planted in other parts of the area. It was explained that fruit trees are being interspaced among the trees. However, fruit trees are not considered to have much of an erosion control effect because of the surface-spreading nature of their root-systems.

Fruit orchards are also being established in more naturally protected areas, such as the agricultural station at Haggatts, where the soil conservation unit is based, propagating thousands of seedlings yearly, many of those being offered for sale to the public.

At the moment Haggetts has some 14 acres devoted to fruit trees such as mangoes, cherries, guavas, paw-paw, citrus, and others. These trees are used mainly as planting material, through budding, grafting and seeds.

Fruits from these trees are sold to staff members with the excess going to the Barbados Marketing Corporation.

APPENDIX H - THE CASE FOR LAND REFORM IN THE CARIBBEAN

by

Dr. Frank Long

Caribbean Contact, August 1982

Land redistribution allows people access to a productive asset thereby giving them scope for participation in productive activity, and the fruits arising therefrom. From the point of view of welfare economics, this case for equity makes intuitive sense.

Evidence from research in Asia, Africa, and latin America suggests that productivity per unit of land used tends to be greater under egalitarian land distribution systems than otherwise.

This is so , it is sometimes argued, because plantations, latifundias, and large-scale capitalists farms are notorious for having excess acreage. This being so, they tend to be relatively inefficient insofar as optimum use of a given area of farm land goes.

This point, however, should not be taken to dispute the fact that with modern techniques of production, e.g. machines and genetic improvements to seeds as well as the payment of low wage rates in relation to average productivity, such farms can reap both benefits of low cost production and high profits.

On the other hand, evidence suggests that with "appropriate technology," adjusted to scale and climatic requirements, small farms can be a technically efficient (and in several instances have revealed greater technical efficiency) as larger farms using sophisticated technologies.

The Caribbean inherited a grossly uneven land distribution system, as part of its plantation legacy. This system was noted for massive consolidation of family holdings during the turn of this century as a large number of

individual family plots (engaged largely in export agriculture) gave rise to concentration of land ownership among a few wealthy families.

Booker McConnell and Tate and Lyle, two of the leading transnational corporations to operate in the Caribbean, were in effect the result of this process of consolidation among plantation owners.

In the 1960's, political independence was obtained by the Most Developed Countries of the Caribbean (Guyana, Barbados, Trinidad and Tobago and Jamaica). During the 1970's governments of most of these countries sought to bring agricultural land formerly owned by expatriate corporations, under some form of national economic control.

For example, Booker McConnell was nationalised in Guyana, Trinidad and Tobago and Jamaica instituted forms of state participation in the plantation sector, and in Barbados government began to show special concern in the country's sugar industry in an effort to nationalize the industry.

In spite of varying ideological positions, the rationale behind different forms of state involvement in Caribbean agriculture was essentially to bring such economies under greater national control.

Prospects for Development

Such control, it was argued, was necessary to eliminate the divergence of interests between transnational corporations, and the social interests of the society at large. This was so in an effort to widen the prospects for development.

More interestingly, it was assumed that development was constrained largely because of the following factors:

(1) Profits from trans-nationals were repatriated abroad and were not used for capital accumulation in the Caribbean.

Classical economics and commonsense both teach us that if investible surplus is not regenerated, the growth process of a given economy will ultimately grind to a halt (unless of course, such surpluses can be had from overseas).

(2) Ownership of land (in many instances the most fertile) meant that the benefits of agricultural development were siphoned off by trans-national firms, given the concern to maximise net corporate income or profits. At the same time, it meant growing poverty of the rural masses.

(3) Control over the region's agricultural lands meant further that such corporations were able to exercise control over the macro-economic system given the importance of agriculture to the economies of the Caribbean.

Given the ownership structure of transnationals and the fact that their loci of decision making were often in the parent companies, this posed problems of harmonising the age old welfare problems of private and public interests.

(4) Further, ownership of agricultural resources determined the pattern of social division of labour in the rural Caribbean, i.e. foreigners constituted a privileged social class; whereas the natives tended to be socially marginalised.

Arguably, this served to heighten the dichotomy between the "foreign rich" and the "local poor" and seemed to contradict the very notion of political independence which had earlier brought constitutional autonomy to these contries.

Unhappily for the transnationals engaged in agriculture, the dependency emerged around the same time (as a wave of intellectual protest against the political economy of colonialism, both in Latin America and the Caribbean; it made its mark in Africa somewhat later), and seemed to supply the economic packages to accompany the prevailing mood of political independence.

Thus, many of the arguments for nationalisation and/or greater state control over the rural economy of the Caribbean, were derived from the dependency school. Depending on political persuasions, policies for agrarian development followed suit.

Colonial Era

The available data on land distribution in the Caribbean are patchy and do not readily lend themselves to time series comparisons.

However, they do give some broad indications of the structure inherited from the colonial era. In 1963, 46 percent of the farms in Trinidad and Tobago accounted for only seven percent of total acreage; in 1970 in Guyana, 75 percent of farms represented only eight percent of total acreage; and in Barbados, 78 percent of the farms represented a mere 12 percent of total acreage in 1971.

Data for 1971 further show that farms with 100 or more acres amount to less than 20 percent of all farms but 47 percent of total acreage in Trinidad and Tobago; less than one percent of the farms but 53 percent of total acreage in Jamaica; one percent of the farm and 55 percent of total acreage in Guyana; and in Barbados less than one percent of the farms accounted for 83 percent of the total acreage.

The data are aggregated and do not allow for distinction between the plantation sector (largely export of sugar) and the peasant sector catering largely for the domestic market.

Although we do not have up-to-date statistics on land distribution, evidence seems to point to the fact that the structure of unevenness in land distribution has not changed much from that indicated in the data; and that many small farmers and labouring classes in rural areas are effectively shut out of the land distributive system.

In many instances, namely in the peasant sector, the process of uneven distribution of land may have increased as bigger farms have been swallowing up smaller ones. In the state sector (including that where participative

arrangements exist with nationals) additional lands have been extended in some instances thereby increasing concentration of land ownership.

A possible exception is Guyana, where cooperatives are being encouraged amongst small farmers. But there has been a limited success story here (in terms of the growth of cooperatives).

Further, cooperatives tend to take the existing land distribution system as given and do not generally operate under radical land reform systems.

In the case of Barbados and Trinidad and Tobago, no major land reforms have been enacted. In the case of Jamaica, a partial attempt was made at modifying the position but the course had to take a U-turn, with the assumption to office of a laissez faire government.

Sluggishness

In most of the countries cited, it was assumed that state intervention was more or less a perfect substitute for land reform. By this, the evils associated with plantation agriculture dominated by transnationals, it was assumed, could be brought to an end.

According to a recent Group of Caribbean Experts the Caribbean has indeed made limited headway in land reform. It also identified the region's failure in land reform to be a major factor accounting for the sluggishness of agriculture in the Caribbean. Another commentator recently pointed out that small farmers and the labouring poor in agriculture were experiencing difficulty in obtaining land, while large tracts of agricultural land continued to remain idle on larger farms.

Recent research has also indicated that:

(1) State control of land is not a sufficient guarantee that farmers will regard the land as part of their own.

(2) Rural poverty in the Caribbean is on the increase under the prevailing land distribution arrangements.

(3) Low levels of productivity tend to characterise the region's agriculture, and though further research is needed to identify factors accounting for this, it is well known that the existence of idle agricultural land is a contributing factor.

In some countries, notably Barbados, Jamaica, and Trinidad attempts are now being made to ensure greater rationisation of the sugar industry which still occupies the bulk of land used for agriculture.

If observations are indeed correct, the case for land redistribution in the Caribbean would seem to stem from three points.

First the existence of fragmented plots of land which need to be consolidated to increase economic viability of small farms and to facilitate access by small farmers to land to bring this about.

Second, making idle land from the traditional plantation sector available to the farming population. Thirdly, the need to increase the involvement of farmers and the rural poor in rural development.

The first two points deal directly with efficiency in agriculture, and the last one concerns principles of welfare. They are both central to any challenge aimed at bringing about progress in agriculture in the Caribbean.

As is well known, land reform is not enough; farmers must have access to credit, technology, markets, infra-structure, and fair prices, amongst others to ensure that the seeds for developing are sown.

APPENDIX I - A WORLD WITHOUT TREES?

by Dr. Patrick Fairbairn

Caribbean Contact, August, 1982

KINGSTON - Like children, trees require care and attention to thrive and grown large. 'For every child a tree' was the theme of this year's International Environment Day celebrations in Jamaica.

Why have trees been singled out this year for special attention? Perhaps because they have been taken too much for granted.

They have been there to cut, burn and put to any of a thousand uses. Now that our population has grown to such large dimensions, trees can no longer support the many demands we make on them without good care from us in return.

Throughout the world more trees are being cut than are being planted. Thailand has deployed its armed forces to guard her remaining forests from illegal clearance.

The drought last summer in Haiti was blamed by some partly on deforestation, which increased the reflection of light and heat from the white limestone hills, reducing condensation and subsequent rainfall.

Earlier this year, visiting biologist Dr. Charles Woods, of the Florida State Museum, warned at a meeting of the Natural History Society of Jamaica's deforestation continued at its present rate, the country would end up like Haiti in 30 years.

Trees are important as communities rather than individuals for soil protection and enrichment, water supply, flood prevention and wild fire protection.

The forest canopy breaks the fall of rain-drops and eases them down gently to the ground, thus reducing transport of soil downhill. The mat of leaf and branch litter creates a porous organic top soil that lets rain water filter down through it rather than flow away on the surface.

The roots stabilise slopes against sheet erosion and land-slips. Roots also take up soil nutrients leached out of the upper soil layer, returning them above ground for further use in plant and animal tissue. Many tree species can increase the amount of soil nitrogen by fixing atmospheric nitrogen in the roots with the aid of certain bacteria.

By encouraging infiltration of rainwater, trees help collect and store it in the soil for gradual release to springs and wells at lower elevations.

Droplets are combined from every passing cloud that touches tree-top level and these trickle down to earth. The more leaves in contact with the cloud, the more water is captured in this way.

Trees are also vital for flood prevention. By reducing the surface runoff of rainwater, trees moderate the drastic fluctuations in river flow that result from forest clearance.

Food and Fuel

Most of our land animals and plants could not exist without trees. Many birds take food directly in the form of insects feeding on the trees. Many frog and lizard species live entirely in trees, and most birds nest there. Most of our orchids and bromelaids are epiphytes which require trees in which to lodge and mature.

In the urban environment, trees can be strategically planted to help modify microclimates and aleviate environmental stress. Strong winds in open areas and around tall buildings can be greatly slowed by proper placement of trees.

Trees are very effective in trapping dust, soot, and other airborne particles, and also in absorbing poisonous gases like sulphur dioxide.

It is now proved that barriers of vegetation muffle traffic noise and act as a buffer between zones of industrial and residential activity.

Trees and shrubs planted along the strips of divided highways provide an economical and attractive barrier to the dazzle of oncoming vehicle headlights. Buildings and open spaces may be similarly protected from the intrusion of any objectionable light source such as reflection from streets, glass windows, zinc roofs and vehicles.

Mahogany

Trees provide lumber and furniture wood. During the 18th Century, our West Indian mahogany was nearly as important to Jamaica as sugar is today and specimens over 100 feet high and 12 feet in diameter were not uncommon.

These have given way to agriculture, but native trees are rapidly appreciating in value as they become scarcer, being highly prized for their durability, variety and beauty.

Do we remember that trees also gave us food? Breadfruit from the South Pacific, mango from South East Asia; Pawpaw and avocado pear from Central and South America, ackee from Africa and what was here to greet the first visitors to Jamaica,star apple. Trees give us orange juice and lemonade, the unique taste of tamarind and soupsop; coffee tea and chocolate--to mention just a few.

For fuel: As a source of renewable energy, trees are both neglected and misused.

Many species are capable of producing up to two-thirds the heat value of an equivalent weight of good coal, but attempts are only now being made in some countries to develop plantations for thermal power generation.